PROJECT 2

DEE 50102

TITLE:GLOVE FINGER REHABILITATION

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CLASS:DEU 5B

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In the name of the most loving and loving God, Salawat and greetings to the Prophet Muhammad Ibn Abdullah, his holy family member and his chosen companions. Alhamdulillah, we express our gratitude to God for His authorization, mercy and guidance enable us to complete the full report on this project.

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ABSTRACT

Stroke is one of the top five diseases in Malaysia contributing to major morbidity and mortality not only in Malaysia but in the whole world. Severe stroke can lead to death while the stroke survivors will face weakness (flaccid), spasticity and decrease in proprioceptive sensation depending on the affected part of the brain. The cost of **rehabilitation** session as well as the restriction in mobility demotivates the patient to undergo rehabilitation therapy in occupational therapy. Glove Finger Rehabilitation has been **developed** for patient to do a daily treatment without frequent assistance from therapist. The patient would practice grasp and release concept of their finger mobility in a self-help manner. This glove-like device uses the application of **Arduino Mega** and **servo motor** mechanical as a main component and has been identified as the most suitable concept for this project.Glove Finger Rehabilitation also applying a **green technology concept** which is related with the **environment**. The design were created to suit perfectly with patient's wrist and finger. Quantitative analysis was conducted to acquire public opinion on the prototype produced. Strongly, all of them agreed on this concept although a lot of improvement needs to be done regarding the design of the prototype.

Keywords*: stroke, developed, rehabilitation, Arduino Mega, servo motor, green technology concept, environment*

ABSTRACT FOR SOFTWARE

Stroke is one of the top five diseases in Malaysia contributing to major morbidity and mortality not only in Malaysia but in the whole world. Severe stroke can lead to death while the stroke survivors will face weakness (flaccid), spasticity and decrease in proprioceptive sensation depending on the affected part of the brain. The cost of **rehabilitation** session as well as the restriction in mobility demotivates the patient to undergo rehabilitation therapy in occupational therapy. Glove Finger Rehabilitation has been **developed** for patient to do a daily treatment without frequent assistance from therapist. The patient would practice grasp and release concept of their finger mobility in a self-help manner. This glove-like device uses the application of **Arduino Mega** and **servo motor** mechanical as a main component and has been identified as the most suitable concept for this project.Glove Finger Rehabilitation also applying a **green technology concept** which is related with the **environment**.Arduino Mega the best choice among the others because it probably the best easy programming for beginners. Arduino Mega is the main board in this project and we also use servo motor and rechargeable battery that portable to bring anywhere so it can attract more attention from hospital and patient to get our equipment.The design were created to suit perfectly with patient's wrist and finger. Quantitative analysis was conducted to acquire public opinion on the prototype produced. Strongly, all of them agreed on this concept although a lot of improvement needs to be done regarding the design of the prototype.

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Chapter 1

Introduction

Stroke is the third largest cause of death in Malaysia. Only heart disease and cancer cope. It is considered the main cause of severe disability, and every year, an estimated 40,000 Malaysians suffer a stroke [2]. Preventing a stroke from happening is comparable to preventing cancer from developing; unattainable. Insufficient blood flow to the brain can occur at any age, causing brain cell damage which leads to memory loss, loss of vision and impaired mobility dependent upon which side of the brain is affected. Physical therapy is vital to recovery and current rehabilitation products such as our glove*;* hand treatment, is in need of much improvement. Stroke victims have greatly increased in recent years and the technology has remained dormant. The existing design lacks proper function and accessibility for individuals who have become paralysed due to a stroke. A new/modified design is imperative to actually aiding these people. The design will focus on the patient; their input will be essential to designing a new product that will be of benefit to regaining muscle function in their hand. With a modification, stroke survivors will be able to access the hand treatment therapy on their own and proceed to incorporating their thumb and fingers in everyday activity while benefiting from the physical therapy aspects of the product.

Stroke have 3 categories which are transient ischemic Attacks, ischemic stroke and haemorrhage stroke. This three categories of stroke affecting in patient arm. Haemorrhage stroke is very dangerous stroke. It can cause die. While the transient ischemic attacks and ischemic stroke can be treat [3]. My group decide to create glove for rehabilitation patient after stroke, we name as Glove Finger Rehabilitation (GFR).

Glove finger rehabilitation (GFR) is a glove that will be a therapy equipment at patient's finger. We build this glove to help patient to grip and release their hand. For our final project, we create and focus our Glove Finger Rehabilitation by using green term. We focus low cost therapy equipment which we decide to use a recycle thing such as plywood, spring and PVC. Arduino is the main board in this project. We also use servo motor and rechargeable battery that portable to bring anywhere so it can attract more attention from hospital and patient to get our equipment. This GFR suitable for patient in adult and above. It is in free size glove.

1.1 Background project

- Glove finger rehabilitation is a glove that will be a therapy equipment at patient finger. It build to help patient to grip and release their hand.
- We create and focus our Glove Finger Rehabilitation by using green term.
- We focus for a low cost therapy equipment which decide to use a recycle thing such as box.
- Arduino is the main board in this project and we also use servo motor and rechargeable battery that portable to bring anywhere so it can attract more attention from hospital and patient to get our equipment.

1.2 Problem statement

Nowadays, patients who are suffered from stroke diseases always have issues or difficulties in starting their own rehabilitation or recovery especially by the guided of physiotherapy specialised or even home physiotherapy by their own. This problem will absolutely effect their own health to the point where they no longer can be cured.

One of the top excuses or problems that have been state by most of the patients are their guardian didn’t have enough time to give a full commitment in every appointment that they have to attend at the hospital. Besides, the certain robotic devices has been developed especially for shoulder, elbow,wrist and finger rehabilitation. However, devices for finger rehabilitation are still limited till this day.

Nowadays, the patients had a little awareness on how effectively the rehabilitation by using the technology. Furthermore, the patients also have financial problem to afford physiotherapy session that absolutely will cost them a number of money.

1.3 Objective

1. To develop for Glove Finger Rehabilitation Controller by using Arduino .
2. Invent and innovate “Glove Finger Rehabilitation controller " to helps stroke patients to hold hands stronger.
3. To develop a device for patient having daily treatment without frequent assistance from therapist.

1.4 Scope of project.

This project will develop a new device that can perform physiotherapy own without the need for detailed supervision of a doctor. There were three main scope for this project, the first scope is ages that has been decide to focus on the ages between 30 to 80 years old only. Secondly this project are been focused on patient who got stroke especially the stroke that involve arm and more specific the area from wrist to finger of the patient. Lastly, this project also can be both using by man and woman.

LITERATURE REVIEW

2.1 Introduction

Literature review is a type of study which has been done in process designing in project. This chapter include the study of different types of stroke and the type of Rehabilitation Therapy and Exercise for Finger Disability. It also find out most suitable design circuit to use in this project. It shown about the component that been used in this Glove Finger Rehabilitation.

2.2 Stroke

Stroke is a medical emergency. Strokes happen when blood flow to your brain stops. Within minutes, brain cells begin to die. There are two kinds of stroke. The more common kind, called ischemic stroke, is caused by a blood clot that blocks or plugs a blood vessel in the brain. The other kind, called haemorrhagic stroke, is caused by a blood vessel that breaks and bleeds into the brain. "Mini-strokes" or transient ischemic attacks (TIAs), occur when the blood supply to the brain is briefly interrupted [6].

Physical effects on either side of the brain. Stroke usually affects one side of the brain. Movement and sensation for one side of the body is controlled by the opposite side of the brain. This means that if your stroke affected the left side of your brain, you will have problems with the right side of your body. If your stroke affected the right side of your brain, you will have problems with the left side of your body [7]. Stroke patients suffer with varies condition depends on the part of the brain damage. The stroke will be effect on the half side (unilateral) and opposite of body depending on which part of the brain damage.

The Symptoms of stroke are patient sudden numbness or weakness of the face, arm or leg (especially on one side of the body). After that, patient sudden confusion, trouble speaking or understanding speech. Next, patient sudden trouble seeing in one or both eyes. Then, patient will sudden trouble walking, dizziness, loss of balance or coordination. Lastly, patient sudden severe headache with no known cause [3].

2.3 Symptom of Stroke (Brain)

When this happens, the brain does not get enough oxygen or nutrients which causes brain cells to die. Strokes occur due to problems with the blood supply to the brain; either the blood supply is blocked or a blood vessel within the brain ruptures.

2.4 Three main kinds of stroke:

There are three main of stroke which is Ischemic stroke, Haemorrhagic stroke and transient ischaemic attack (TIA).

1. **Ischemic Stroke**

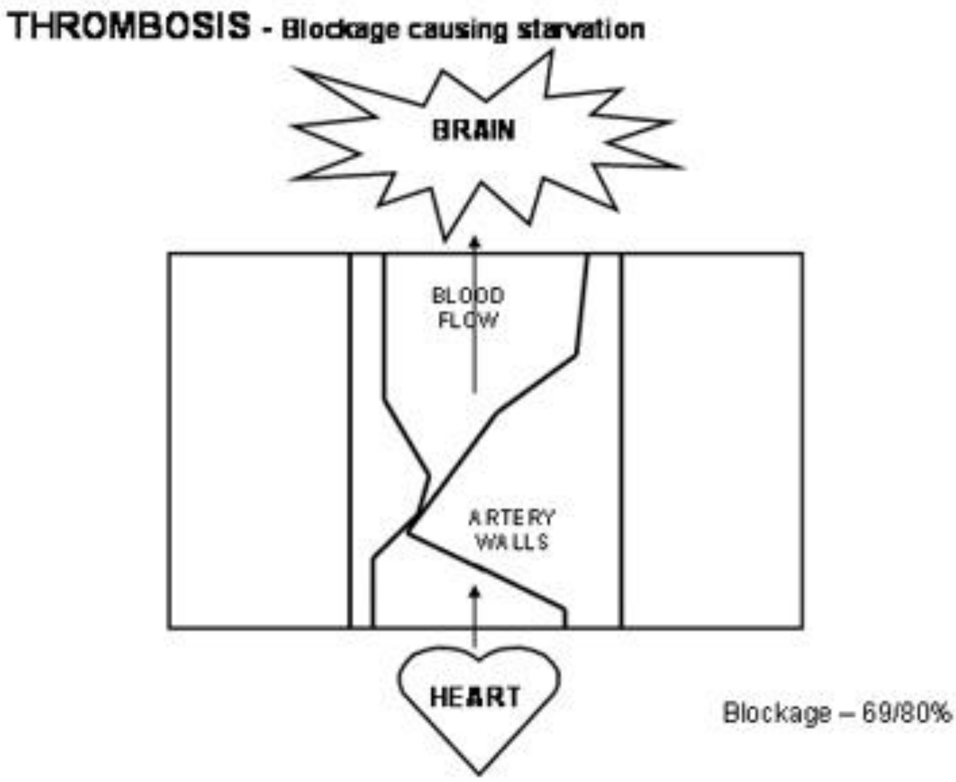


Figure 2.1

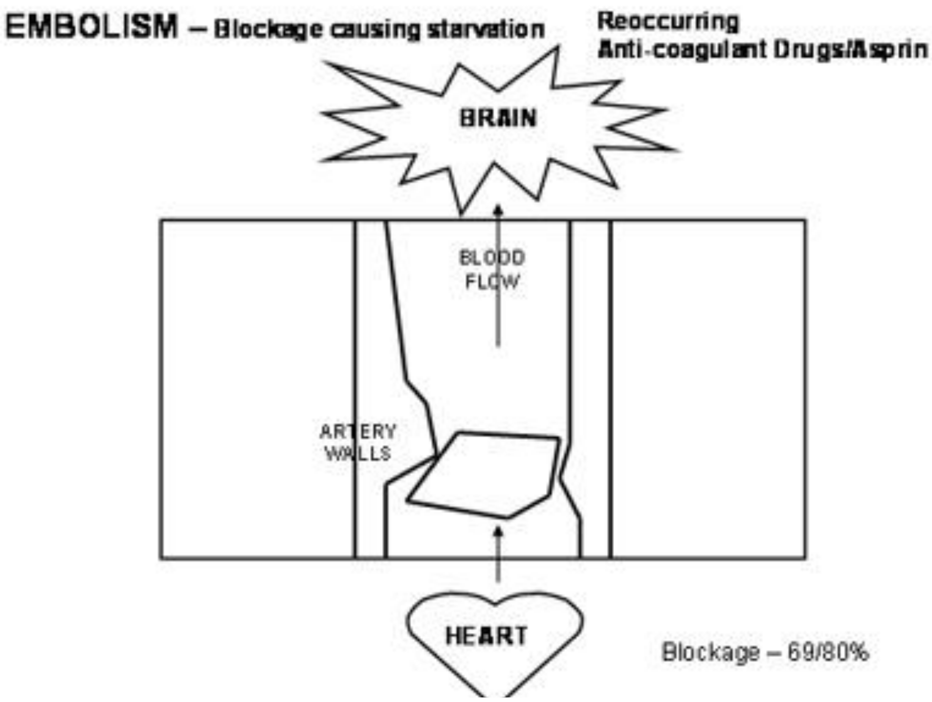


Figure 2.2

This happens when blood vessels are blocked by a clot or become too narrow for blood to get through to the brain. The reduced blood flow causes brain cells in the area to die from lack of oxygen [3].

2. **Haemorrhagic stroke**

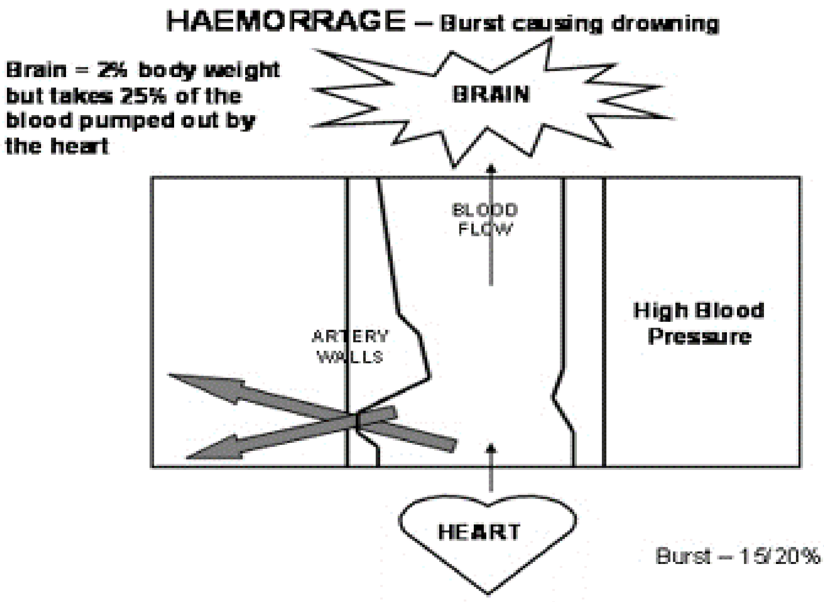


Figure 2.1

The blood vessel is not blocked but it bursts and blood leaks into the brain causing damage [3].

3. **TIA (transient ischaemic attack)**

Figure 2.2

A mini-stroke – the effects usually pass quickly but a TIA must be taken seriously as it can be a warning sign**.** A transient ischemic attack (TIA) happens when blood flow to part of the brain is blocked or reduced, often by a blood clot. After a short time, blood flows again and the symptoms go away. With a stroke, the blood flow stays blocked, and the brain has permanent damage. Some people call a TIA a mini-stroke, because the symptoms are those of a stroke but don't last long. A TIA is a warning: it means you are likely to have a stroke in the future. If you think you are having a TIA, call 911 or other emergency services right away. Early treatment can help prevent a stroke. If you think you have had a TIA but your symptoms have gone away, you still need to call your doctor right away [3].

Symptoms of a TIA are the same as symptoms of a stroke. But symptoms of a TIA don't last very long. Most of the time, they go away in 10 to 20 minutes. They may include a sudden numbness, tingling, weakness, or loss of movement in your face, arm, or leg, especially on only one side of your body. Next, sudden vision changes. After that, patient will sudden trouble speaking, sudden confusion or trouble understanding simple statements. After that, patient will sudden problems with walking or balance.

A blood clot is the most common cause of a TIA. Blood clots can be the result of hardening of the arteries (atherosclerosis), heart attack, or abnormal heart rhythms. The clot can block blood flow to part of the brain. Brain cells are affected within seconds of the blockage. That causes symptoms in the parts of the body controlled by those cells. After the clot dissolves, blood flow returns, and the symptoms go away. Sometimes a TIA is caused by a sharp drop in blood pressure that reduces blood flow to the brain. This is called a "low-flow" TIA. It is not as common as other types [3].

2.5 Ischemic stroke

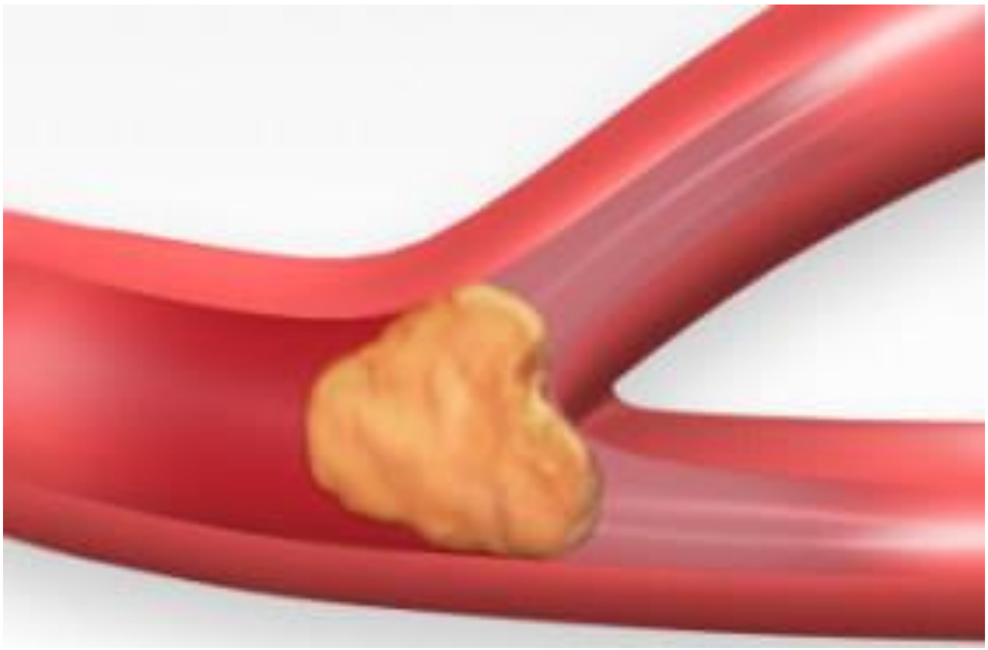


Figure 2.3

Ischemic stroke accounts for about 87 percent of all cases. Ischemic strokes occur as a result of an obstruction within a blood vessel supplying blood to the brain. The underlying condition for this type of obstruction is the development of fatty deposits lining the vessel walls. This condition is called atherosclerosis [8].

These fatty deposits can cause two types of obstruction which are cerebral thrombosis and cerebral embolism. **Cerebral thrombosis** refers to a thrombus (blood clot) that develops at the clogged part of the vessel. **Cerebral embolism** refers generally to a blood clot that forms at another location in the circulatory system, usually the heart and large arteries of the upper chest and neck. A portion of the blood clot breaks loose, enters the bloodstream and travels through the brain's blood vessels until it reaches vessels too small to let it pass. A second important cause of embolism is an irregular heartbeat, known as atrial fibrillation. It creates conditions where clots can form in the heart, dislodge and travel to the brain. Silent cerebral infarction (SCI), or “silent stroke,” is a brain injury likely caused by a blood clot interrupting blood flow in the brain. It’s a risk factor for future strokes which could lead to progressive brain damage due to these strokes [8].

2.6 Haemorrhagic stroke

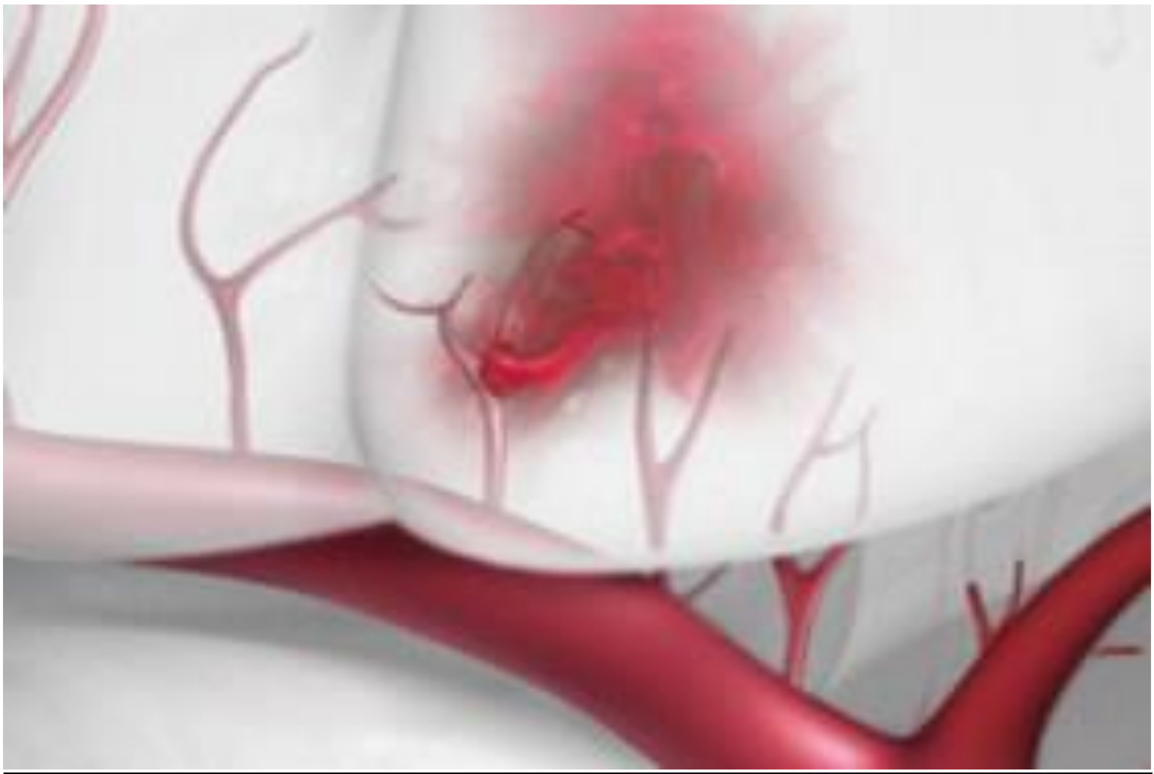
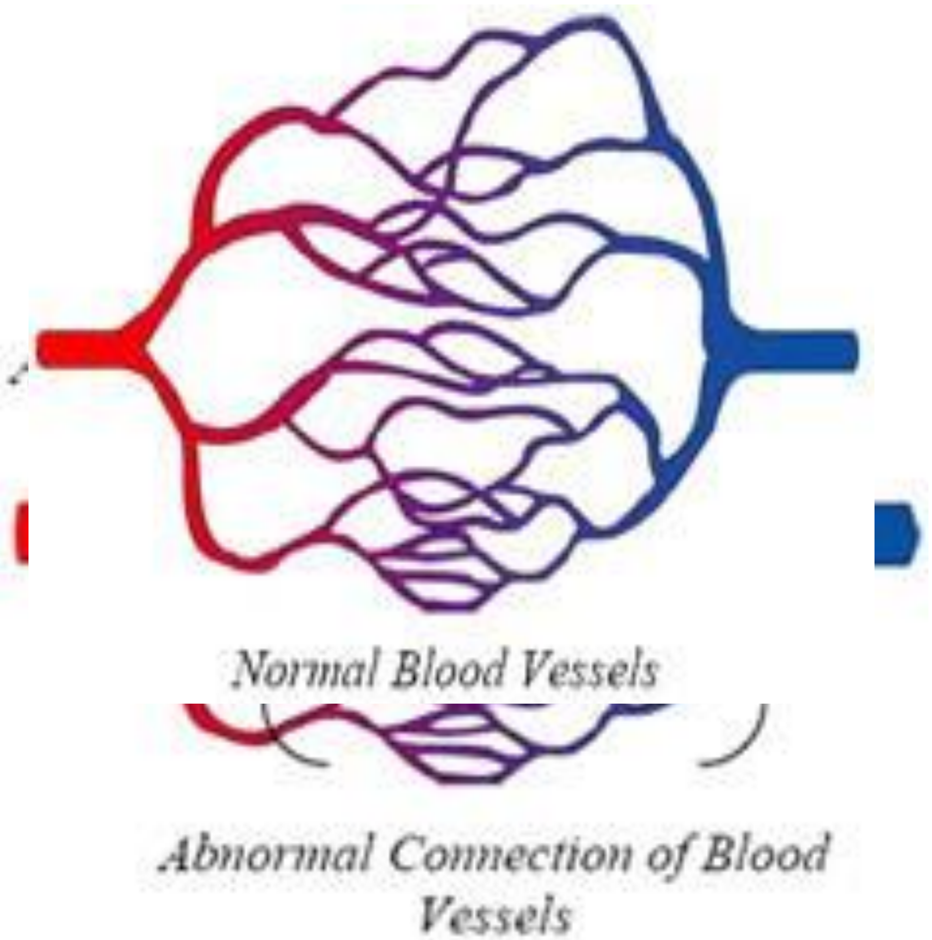


Figure 2.4

Haemorrhagic stroke accounts for about 13 percent of stroke cases. It results from a weakened vessel that ruptures and bleeds into the surrounding brain. The blood accumulates and compresses the surrounding brain tissue. The two types of haemorrhagic strokes are intracerebral (within the brain) haemorrhage or subarachnoid haemorrhage. Haemorrhagic stroke occurs when a weakened blood vessel ruptures. Two types of weakened blood vessels usually cause haemorrhagic stroke: aneurysms and arteriovenous malformations (AVMs) [8].

An **aneurysm** is a ballooning of a weakened region of a blood vessel. If left untreated, the aneurysm continues to weaken until it ruptures and bleeds into the brain. An **arteriovenous malformation** (AVM) is a cluster of abnormally formed blood vessels. Any one of these vessels can rupture, also causing bleeding into the brain [8]

Figure 2.7



Normally, **arteries** carry blood containing oxygen from the heart to the brain, and **veins** carry blood with less oxygen away from the brain and back to the heart. When an **arteriovenous malformation (AVM)** occurs, a tangle of blood vessels in the brain or on its surface bypasses normal brain tissue and directly diverts blood from the arteries to the veins.

Figure 2.5

Brain AVMs occur in less than 1 percent of the general population. It's estimated that about one in 200–500 people may have an AVM. AVMs are more common in males than in females. People don't know why AVMs occur. Brain AVMs are usually congenital, meaning someone is born with one. But they're usually not hereditary. People probably don't inherit an AVM from their parents, and they probably won't pass one on to their children [8]. Brain AVMs can occur anywhere within the brain or on its covering. This includes the four major lobes of the front part of the brain (frontal, parietal, temporal, occipital), the back part of the brain (cerebellum), the brainstem, or the ventricles (deep spaces within the brain that produce and circulate the cerebrospinal fluid) [8].

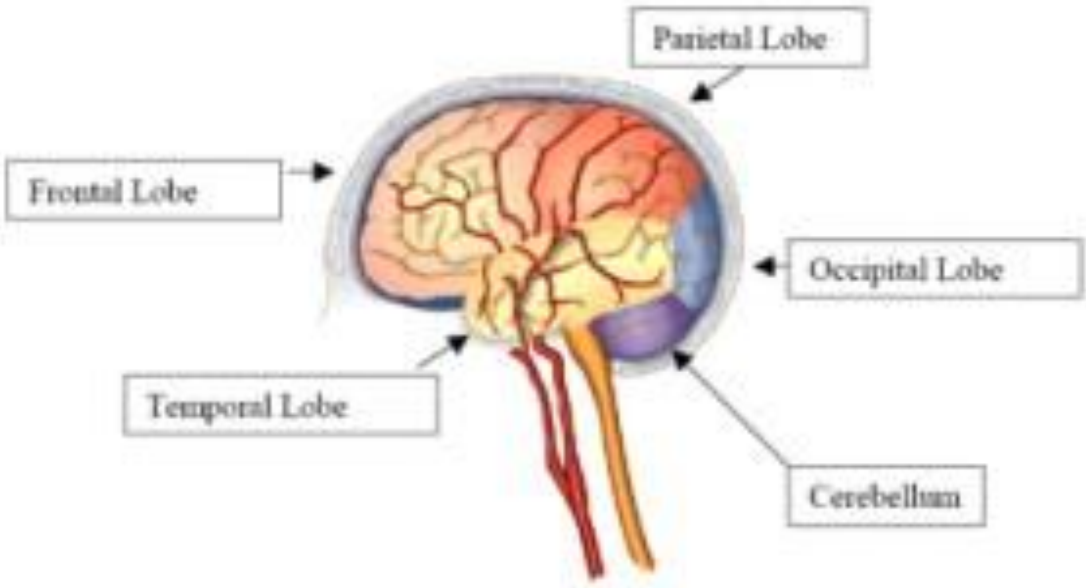


Figure 2.6

Most AVMs don’t grow or change much, although the vessels involved may dilate (widen). Some AVMs may shrink due to clots in part of the AVM. Some may enlarge to redirect blood in adjacent vessels toward an AVM. Symptoms may vary depending on where the AVM is located more than 50 percent of patients with an AVM have an intracranial haemorrhage. Among AVM patients, 20 percent to 25 percent have focal or generalized seizures. Patients may have localized pain in the head due to increased blood low around an AVM. Fifteen percent may have difficulty with movement, speech and vision. A brain AVM contains abnormal and, therefore, “weakened” blood vessels that direct blood away from normal brain tissue. These abnormal and weak blood vessels dilate over time. Eventually they may burst from the high pressure of blood flow from the arteries, causing bleeding into the brain. The chance of a brain AVM bleeding is 1 percent to 3 percent per year. Over 15 years, the total chance of an AVM bleeding into the brain — causing brain damage and stroke — is 25 percent.

The risk of recurrent intracranial bleeding is slightly higher for a short time after the first bleed. In two studies, the risk during the first year after initial bleeding was 6 percent and then dropped to the baseline rate. In another study, the risk of recurrence during the first year was 17.9 percent. The risk of recurrent bleeding may be even higher in the first year after the second bleed and has been reported to be 25 percent during that year. People who are between 11 to 35 years old and who have an AVM are at a slightly higher risk of bleeding. The risk of death related to each bleed is 10 percent to 15 percent [8]. The chance of permanent brain damage is 20 percent to 30 percent. Each time blood leaks into the brain, normal brain tissue is damaged. This results in loss of normal function, which may be temporary or permanent. Some possible symptoms include arm or leg weakness/paralysis, or difficulty with speech, vision or memory. The amount of brain damage depends on how much blood has leaked from the AVM.

If an AVM bleeds, it can affect one or more normal body functions, depending on the location and extent of the brain injury. Different locations in the brain control different functions are Frontal lobe controls personality, Parietal lobe controls movement of the arms and legs, temporal lobe controls speech, memory and understanding, Occipital lobe controls vision, The cerebellum controls walking and coordination, Ventricles control the secretion of cerebrospinal fluid, The brainstem controls the pathways from all of the above functions to the rest of the body.

All blood vessel malformations involving the brain and its surrounding structures are commonly referred to as AVMs. But several types exist t**rue arteriovenous malformation (AVM).** This is the most common brain vascular malformation. It consists of a tangle of abnormal vessels connecting arteries and veins with no normal intervening brain tissue. **Occult or cryptic AVM or cavernous malformations.** This is a vascular malformation in the brain that doesn't actively divert large amounts of blood. It may bleed and often produce seizures. **Venous malformation.** This is an abnormality only of the veins. The veins are either enlarged or appear in abnormal locations within the brain. **Haemangioma.** These are abnormal blood vessel structures usually found at the surface [8].

2.7 Hand Disabilities

Most common disability by stroke is paralysis or problems controlling movement (motor control) [9]. Motor control is motor learning loosely or abnormal that encompasses motor adaptation, skill acquisition and decision making [10]. Half side paralysis of body called hemiparesis where the stroke suffer having difficulties of doing daily activities such as picking small objects, grasping or eating [11]

Hand therapy exercises after stroke will help regain the fine motor skills and finally get your hand back. Hand movement is one of the most stubborn functions to get back after stroke, so it’s important to experiment with all of your options and find the one that works best for you.

2.8 The type of Rehabilitation Therapy and Exercise for Finger Disability

1. 2 Hand Stretching Exercises

These stretching exercises can be practiced passively or actively. For those with paralyzed hands, patient can practice these stretching exercises passively by using unaffected hand to help complete the exercises. This will help prevent muscle stiffening and encourage movement in affected hand. For those who do have some movement in their hand, patient can practice these stretching exercises actively (meaning no assistance from patient unaffected hand) as a good warm up activity [12].

a) Wrist Extension and Flexion

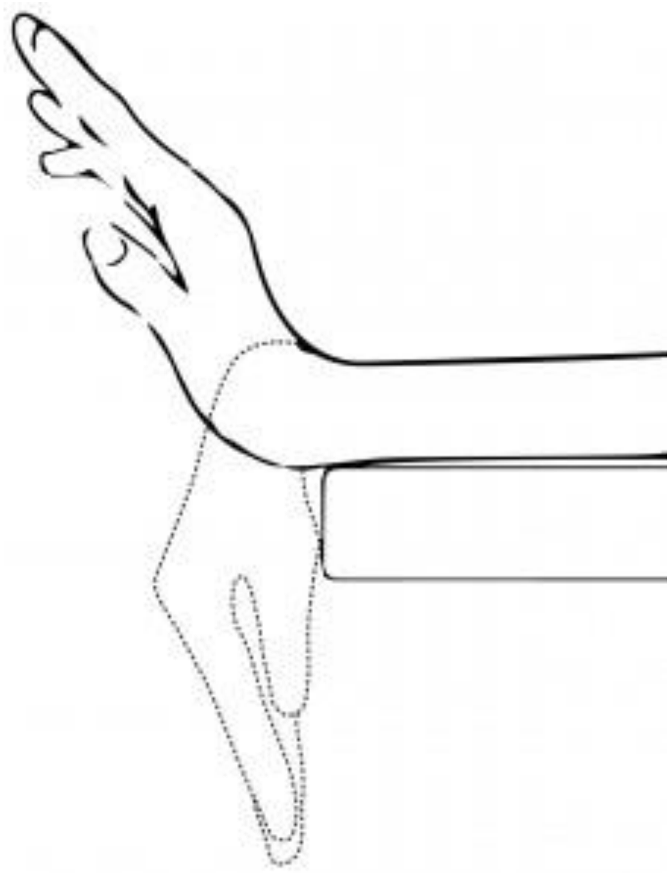


Figure 2.7

With forearm on a table, let the hand hang off the side of the table with palm down. Then, move hand up and down, bending at wrist. When it done, repeat with your palm facing up [12].

b) Thumb Extension and Flexion

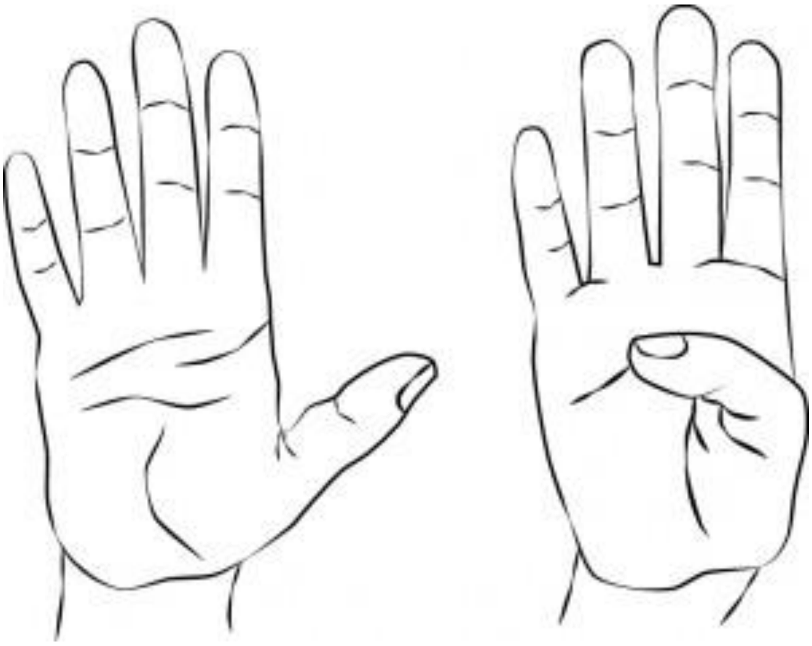


Figure 2.8

Start with patient palm open, as if patient were signalling the number 5. Then, practice moving thumb over to pinky side, as if were signalling the number 4. Continue to move thumb back and forth between these 2 positions [12].

2. 6 Easy Hand Therapy Exercises

For those with some hand movement, try these simple tasks that involve common household items. There were six easy way to running a Hand Therapy Exercise, stacking coins, pinching clothespins, playing board games like chess or checkers, putting together a puzzle, playing the piano and lastly paying a virtual piano app.

3. 2 Rotation and Shift Hand Exercises

Once patient mastered the complex hand manipulation exercise, patient will be ready to work on performing rotation and shift exercises. Take a pen, and try rotating it around middle finger, using thumb, index, and ring finger to help patient manipulate the pen. Think about twirling the pen around fingers. Then, practice a shifting movement by holding the pen in a writing position (in between thumb, index, and middle finger) and shifting the pen forward until patient are holding the end of the pen. Then, shift the pen back until holding the tip once again. Think about inching fingers along the pen [12]

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4. An Advanced Hand Exercise

For this complex hand exercise, gather 10 small objects (like uncooked beans) and practice picking them up with patient fingers. But instead of immediately setting them down, try holding all of the objects in your palm (of the same hand) while continue to pick the rest up. Patient will be working on pinching movements with index finger and thumb while the rest of fingers work to keep the objects in palm. Then, once all the objects are in patient hand, practice putting them down one by one. Patient will use their thumb to move each object from palm down to index finger and thumb, and then place the object back down onto the table. This requires a great deal of coordination and control, so if patient can't get it at first, remember that it's a difficult task and patient will get better with practice [12].

5. 8 Hand Therapy Putty Exercises

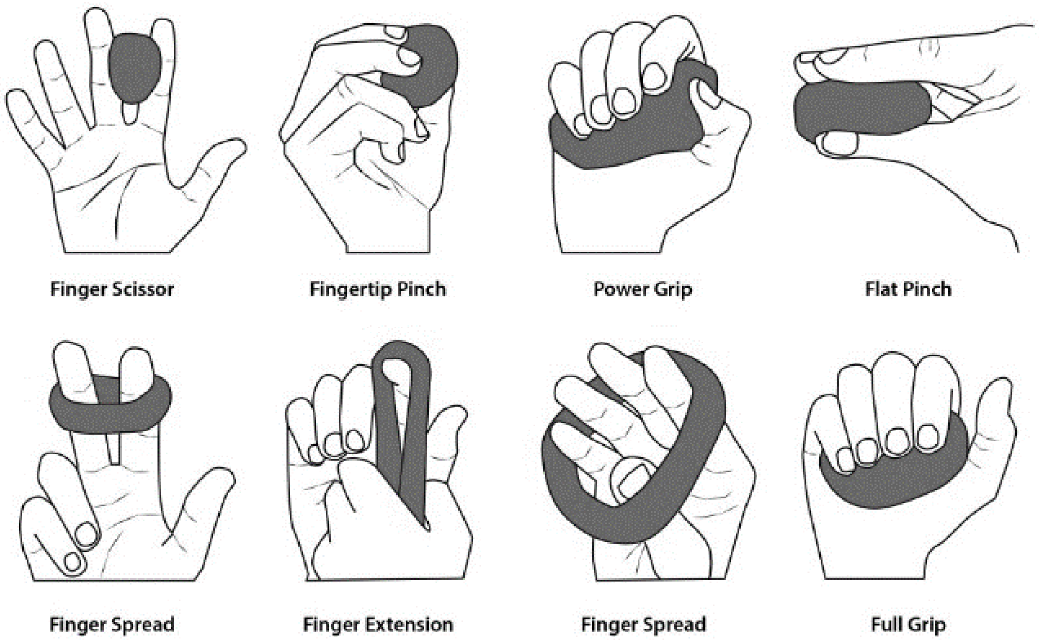


Figure 2.9

For the patient who need a little creativity in doing their own exercise, there are 8 Hand Therapy Putty Exercise are been provided for the patient. First, there were Finger Scissors that need the patient to squeeze the putty between the patient fingers. Second, Fingertip Pinch that involve the patient to pinch the putty using thumb and fingertips. Third, Power Grip who needs the patient to squeeze all your fingers into the putty. Fourth, Flat Pinch that needs to pinch the putty down into patient thumb with straightened fingers. Fifth, Finger Spread that involve the patient to wrap the putty around two fingers and spread your fingers apart. Sixth, Finger Extension that involve the patient to wrap the putty around a hooked finger and then straighten your finger using the putty as resistance Seventh, Finger Spread that needs to wrap the putty around the patient hand and then spread the fingers out to stretch the putty. Lastly, Full Grip involve the patient Squeeze down on the putty, pressing the fingers into your palm [13].

6. 8 Hand Therapy Ball Exercises

Hand therapy balls are the cheapest tools patient can use to regain hand movement after stroke. Try using a soft one if patient still developing strength, and use something more firm if patient focused more on regaining coordination. Hand therapy balls usually come in different thicknesses so that patient can keep yourself consistently challenged [12].

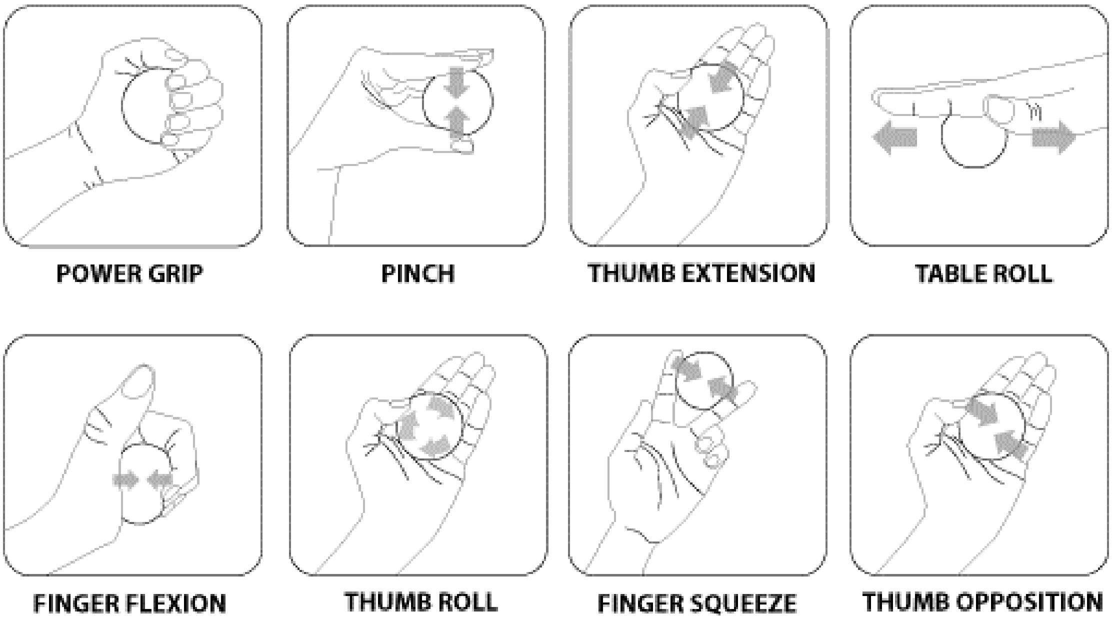


Figure 2.10

There are few way in doing exercise by using only ball to help the patient. First, Power Grip that involve the patient to squeeze the hand therapy ball with their fingers and thumb. Focus on pressing the pads and tips of your fingers into the ball. Second, Pinch that need the patient to pinch the ball with fingers and thumb extended. Press the fingers down into the top of the ball and the patient thumb upward on the bottom of the ball. Third, Thumb Extension that has to roll the ball up and down the patient palm by flexing (making the thumb bent) and extending (making the thumb straight). This will move the ball up and down the patient hand in a somewhat straight motion. Fourth, Table Roll who need the patient to roll the ball from the tip of their fingers to the palm. Fifth, Finger Flexion that involve the patient to hold the ball in their palm and press the fingers into the ball. This is different from the power grip above because they are focusing on an inward movement instead of a global gripping movement.

Imagine that pressing the fingers straight into the palm. Sixth, Thumb Roll that needs to use patient thumb to roll the ball in a circular motion on their palm. Seventh, Finger Squeeze needs the patient to squeeze the ball between two fingers. Lastly, Thumb Opposition that involve the patient to roll the ball side to side on their palm using the thumb [12].

7. Strengthening motor skills

A motor skill is a learned series of movement that combine to produce efficient action. Motor skill can be divided into two: Gross motor skills and fine motor skills. Gross motor skills are concerning for grasping large object, balancing, walking and lifting one's head. The motor development follows a pattern where large muscles develop before smaller ones as ignition to fine motor skills. Fine motor skills include the ability to grasping or picking small object, knitting, writing or transfer objects from hand to hand. These skills required very precise motor movement in order perform delicate task. Combination of small muscle usually performs the task. Weak muscles can effects the motor skill of the stroke patient. Therefore by strengthening motor skills using varies exercise will help improve muscle strength and coordination [13]. Exercise of muscles involving finger extension and flexion to certain degree of movement. The exercise starting from proximal muscle group and extent the distal muscle group at the finger tips.

8. Range of motion therapy (ROM)

Spasticity is one of the effects of stroke. It allows muscle to contract and cannot move anymore. The patient would get out of the way using the impaired hand and do activities using unaffected hand contributing to loss of fine motor control. The upper extremity become worse because of loss of control and increasing impaired. The activities of extent and flexion of finger and improvement of upper extremity will be analysing by range motion therapy (ROM) also as indicator how the patient could compensate for stroke. Range motor therapy is a measurement of the extent and flexion of finger to which a joint can go through all of it normal range of movements. There are two types of motion exercise in rehabilitation therapy: passive and active range motion. The patient will be asked to move a limb repeatedly in passive range motion to avoid the contraction of muscles and active exercise perform by the patient without physical assistance from the therapist usually at home. The patient must do the strengthening and bending of thumb and finger also flexion and extension exercise according schedule in order to make the muscle regain the strength to operate [11].

9. Physical Therapy (Mallet Exercise)

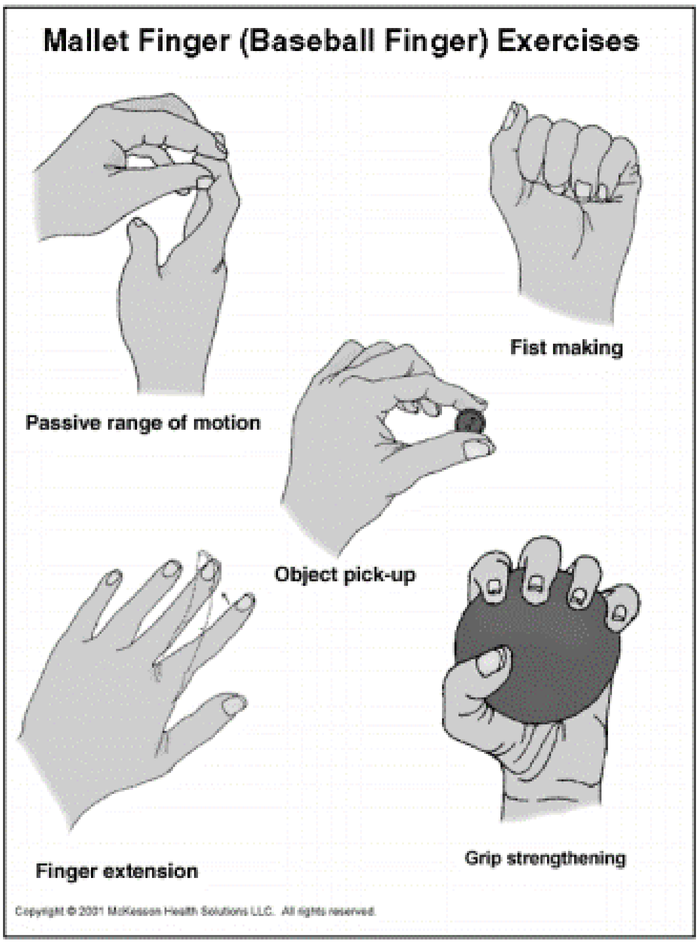


Figure 2.11

There are five recommendations for finger exercise to strengthens and recover the injure finger motion range [11]. First, Passive range motion. Gently assist the injured joint by bending and straighten it with other hand. Do the exercise 10 times by repeating slowly and hold for 5 seconds at the end of each motion. Second, Fist making. Injured finger is assist by uninjured hand to help it bend into a fist. Hold the position for 5 to 10 seconds and repeat for 10 times. Third, Object pick-up. Practicing to pick-up small objects as coins, marbles, pin or button with one finger and the thumb. Fourth, Finger extension. Place the palm flat on a table and straighten the finger out. Lift each finger straight up one at a time and hold for 5 seconds before put it down. Repeat at each finger 10 times at once. Fifth, Grip strengthening. Grasp and squeeze a rubber ball. Holds for 5 seconds [11].

2.9 Brain reorganization after stroke

An online literature search on Pubmed under ‘‘brain reorganization after stroke’’ gives a rough indication of the increase in interest in the neural correlates of recovery from stroke. From 1981 to 1990 there were three publications; from 1991 to 2000, 48; and from 2001 to 2004, [14]. These studies reveal that, in addition to recovery through reduction in oedema and metabolic disturbances, restitution of the ischemic penumbra, and resolution of diastasis, the adult brain is capable of reorganization to recover lost function. Reorganization can occur in cortical regions immediately adjacent to the infarct [15] or remote from the infarct, both in the same [16], and in the opposite hemisphere [17]. The mechanisms of both adjacent and remote reorganization are under active investigation and are thought to include unmasking of latent synapses, facilitation of alternative networks, synaptic remodelling, and axonal sprouting [18, 19]. Several reviews on the subject of brain reorganization have been published recently,[20-26] and so this section will be selective and focus on conceptual and methodological issues pertaining to inferring recruitment of brain areas remote from the infarct.

2.10 Natural history of arm paresis and predictors of recovery

Stroke is the leading cause of long-term disability among adults in the United States, and hemiparesis is the most common impairment after stroke. Longitudinal studies of recovery after stroke suggest that only 50% of patients with significant arm paresis recover useful function. Initial severity of paresis remains the best predictor of recovery of arm function [27, 28]. One study showed that the Fugal-Meyer (FM) [29] score at 30 days predicted 86% of the variance in recovery of motor function at 6 months. This oft-cited study raises several important issues pertinent to the study of stroke recovery [30]. First, the authors make a good case for using a measure of impairment, the FM score, rather than a measure of disability, the Barthes index, to assess recovery of function. The difference between impairment and disability highlights the critical distinction between true recovery and restoration of function, as opposed to compensation. For example, a patient with right arm paresis who learns to perform activities of daily living (ADLs) with her left arm has compensated but has not recovered. Measurements of impairment are more likely than measurements of ADLs or handicap to distinguish true recovery from compensation. Second, the FM score at 30 days was a better predictor of the FM score at 6 months than the FM score at day 5, which indicates that there is significant variability in the degree of spontaneous recovery occurring in the first month post stroke. Third, the finding that most of the variance in outcome at 6 months was determined by the first 30 days implies that whatever occurred in terms of rehabilitation in the ensuing 5 months made little impact. This suggests that patients with the worst prognosis at 6 months need to be the focus of novel and intensive rehabilitation strategies. Indeed, it will be easier to detect an effect of a novel treatment strategy in this group. Attempts to use lesion location to predict arm recovery have so far only been able to show greater probability of recovery from hemiparesis for cortical than for subcortical lesions. In particular, lesions in the most posterior part of the posterior limb of the internal capsule have the poorest outcome, presumably due to convergence of a majority of axons from primary motor cortex (M1). One study followed 41patients, with near plague or plague 2 weeks after stroke (Action Research Arm Test score <9/56), for 2 years.75 percent of those patients with lesions restricted to cortex recovered isolated upper limb movements, whereas only 6% of patients with subcortical strokes did so. This marked difference may be because initial measurements were only 2 weeks post stroke. It is possible that patients with cortical lesions who remain pelagic at 1 month would not show such a favourable outcome. Nevertheless, the results suggest that hemiparesis may come in distinct subtypes. In summary, severity of arm paresis in the first month after stroke remains the strongest predictor of outcome and likely reflects the degree of damage done to cortical motor areas and the corticoid spinal tract. It is to be hoped that the impact of initial severity can be lessened with new rehabilitation techniques in the first 6 months post stroke. Cortical and subcortical strokes may require different rehabilitative approaches. Finally, it is now known that chronic stroke patients(>6 months) respond to rehabilitation, and so it is conceivable that the patients who do not show significant responses by 6 months may need more extended periods of rehabilitation.

2.11 The Ipsilesional Arm

In 1973, Alf Brodal, a Norwegian professor of anatomy, published an article entitled: ‘‘Self-Observations and Neuroanatomical Considerations after a Stroke.’’ [31] This article is filled with observations of great physiological interest. In particular, Brodal became aware that although he had suffered a right subcortical stroke, the quality of his writing with his right hand had deteriorated. Several studies have subsequently reported abnormalities in the ‘‘unaffected’’ arm after stroke, including control of distal movements. Interestingly, the nature of these deficits can differ depending on whether the infarct is in the dominant or no dominant hemisphere [32-33]. Most recently, strikingly abnormal step-tracking movements have been described in the ipsilesional wrist of patients with hemiparesis [34-38]. The observed trajectory errors in amplitude and direction were due largely to inappropriate temporal sequencing of muscle activity [39]. One possible explanation is that there is interruption of the uncrossed ipsilateral corticospinal projection to distal muscles. Support for this explanation comes from functional imaging studies, which show bilateral M1 activation during unilateral finger movements. An alternative explanation isthat stroke in one hemisphere alters transcallosally mediated inhibitory effects on M1 in the opposite hemisphere [40-41]. The involvement of the ‘‘unaffected arm’’ after stroke has several important implications [42-44]. First, even distal control of the arm is under bilateral hemispheric control. Second, age-matched healthy subjects should be used as controls in future studies rather than patients’ unaffected arm. Third, collapsing findings for left and right hemiparesis are questionable given the differences in some control abnormalities in the ipsilesional arm with dominant and no dominant hemisphere strokes. Finally, the involvement of the ipsilesional arm reinforces the importance of sensitive quantitative studies to detect differential abnormalities that would otherwise be missed on bedside examination or by outcome scales.

2.12 Flexion Tracking

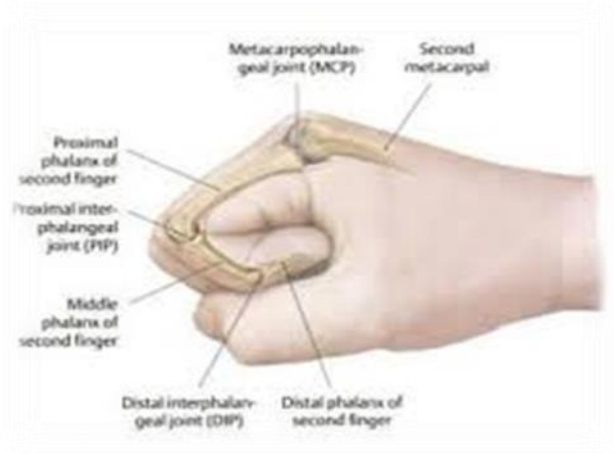


Figure 1.1 Finger flexion with joints identified [2]

Movements and flexing of the fingers is known as flexion of the finger joints. A human finger has an approximate total flexion range of about 260°, although finger joints have varying ranges of motion based on each individual person [1].

The finger joints acquainted with flexion are the distal-interphalangeal (DIP) joint also referred to as the fingertip joint, proximal-interphalangeal (PIP) joint or center joint of the finger, and the metacarpal-phalangeal (MP) joint commonly known as the joint of the knuckles [1]. Fig 1.1 shows the human hand flexed to a clenched fist posture with the main joints articulated to their flexion positions.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Methodology is a system of broad principles or rules from which specific methods or procedures may be derived to interpret or solve different problems within the scope of a particular discipline. Therefore, this chapter will show a through description of the processes used to complete this project.

This project is completed in properly procedure or according to the way of resolving that has been made as an such as process decide a project, do the block diagram of the project, decide the circuit that want to use, decide the main components that want to use, design the project, and process to complete the project.

After that the circuit will be tested whether it is function or not. Once the circuit can fully operate, make a connection between the glove and servomotor using specified string. In this project, the questionnaire was created to observe about the glove finger rehabilitation, this part can be referred in (3.7). This project is considered as succeed once it is fully operated.

3.2 Flow Chart

3.2.1 Process Of Decide Project

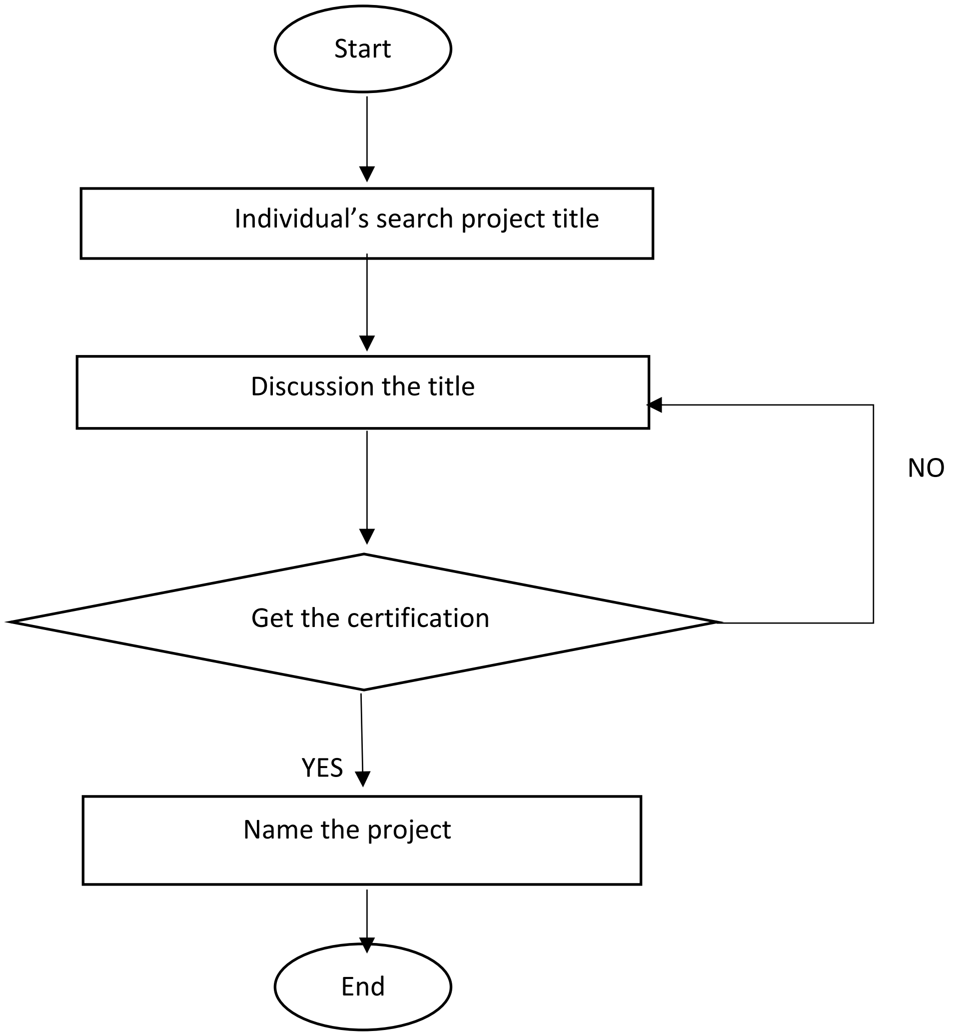


Figure 3.1: Flow chart of decide the project

First of all, each of our group search about title projects by individual. Then, we have discuss about all our project title and choose some project title to get certification from our lecturer. After that, we give name for our project that accepted by our lecturer.

3.2.2 Process Build the Project

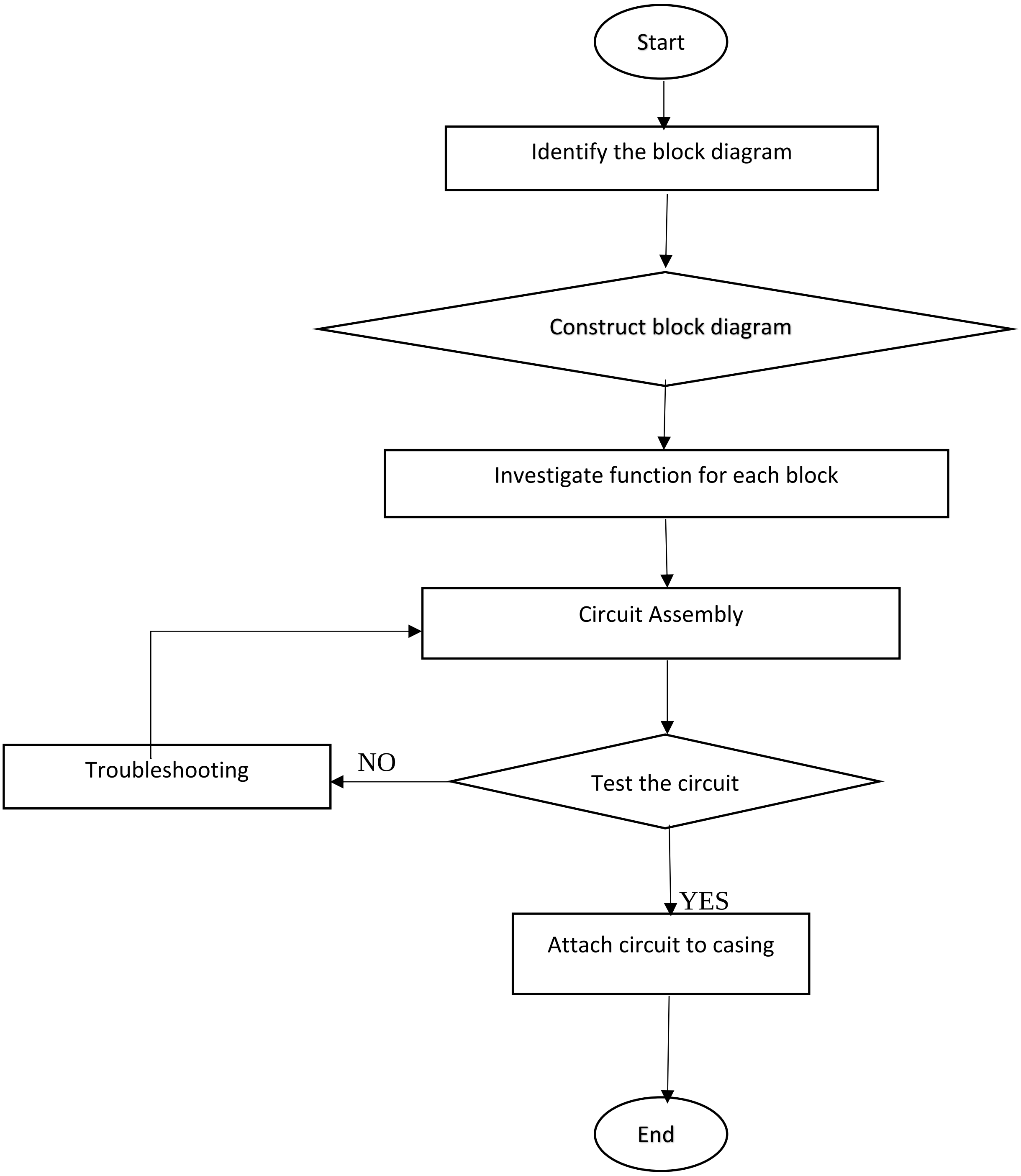
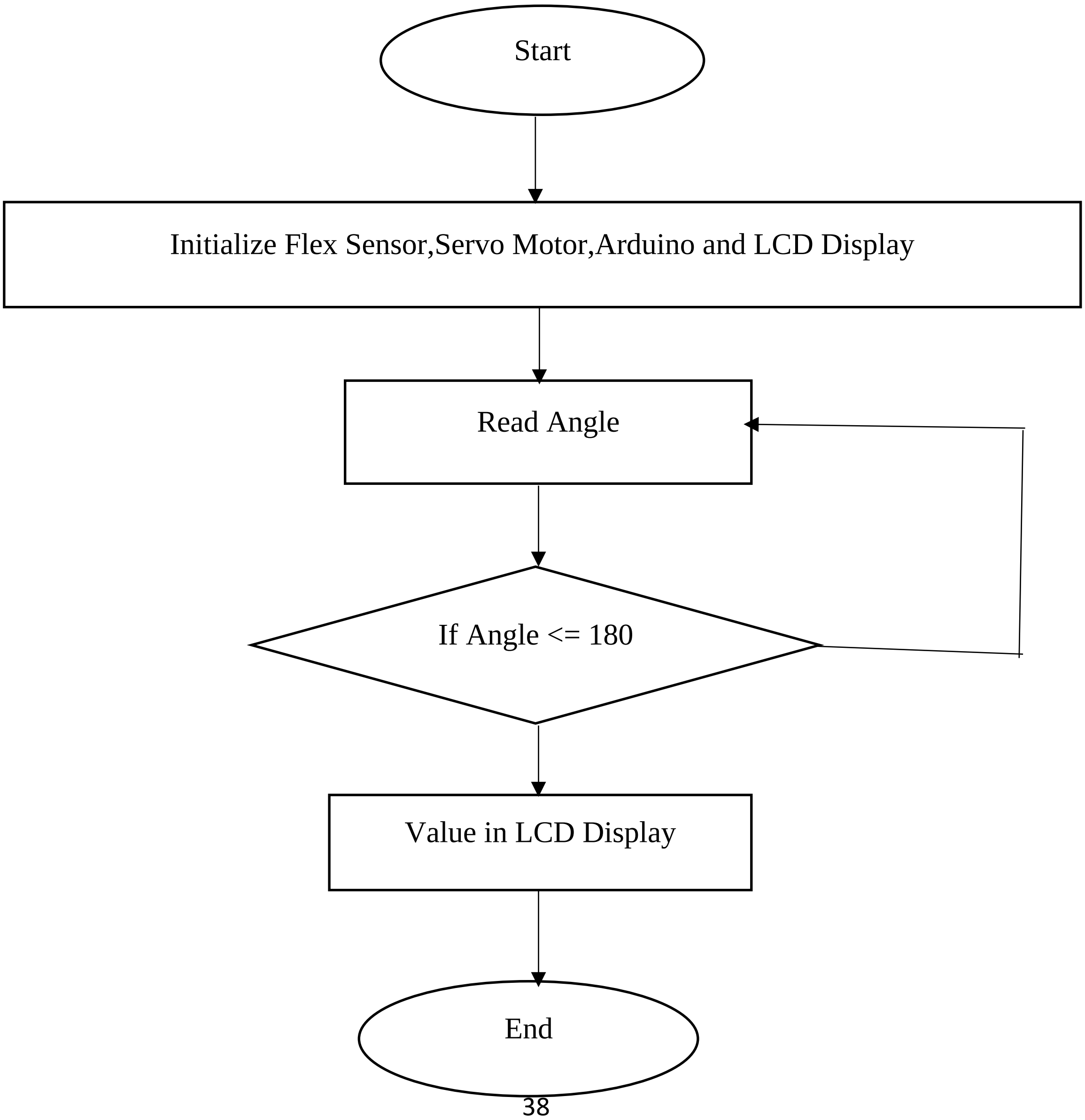


Figure 3.2: Flow chart process of build the project

First of all, the process for building a finger glove recovery (GFR) begins by identifying a block diagram that can show or explain the functionality of the device. Then, the process of building a block diagram begins with the process of identifying the function of the device. The glove finger rehabilitation has a function to help the stroke patients to perform the flexion and extension of the hand (grasp and release). After investigate the all functions of block diagrams process, the decision process to select the components to be used for producing the GFR. All components are selected based on observations on all aspects that benefit the GFR. Besides, the testing process of the circuit whether it can run all five servo motors or not has been done. After all testing process succeed, process to design the circuit casing, glove and the structure project was created.

3.2.3 Process Of Output at LCD Display



3.3 Block Diagram

3.3.1 Block Diagram of Planning Starting Progress to Complete the Project

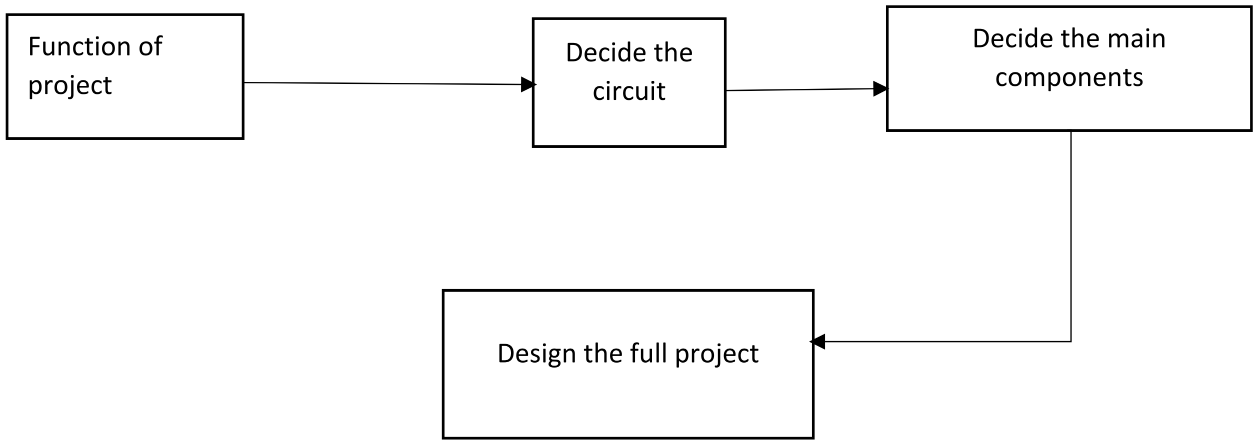


Figure 3.3: Block Diagram of Planning Starting Progress to Complete the Project

First of all, in order to complete the project with the correct procedures, the initial planning development must be established. First, determine the glove finger rehabilitation (GFR) function as it can show the project flow. Second, the circuit's decision has been made based on the GFR function. The circuit is selected based on observations on all aspects that benefit GFR. Third, the main component of GFR is decided as the type of servo motor. Finally, full project design has begun. Example, glove design and structural project design.

3.3.2 Block Diagram of the Project

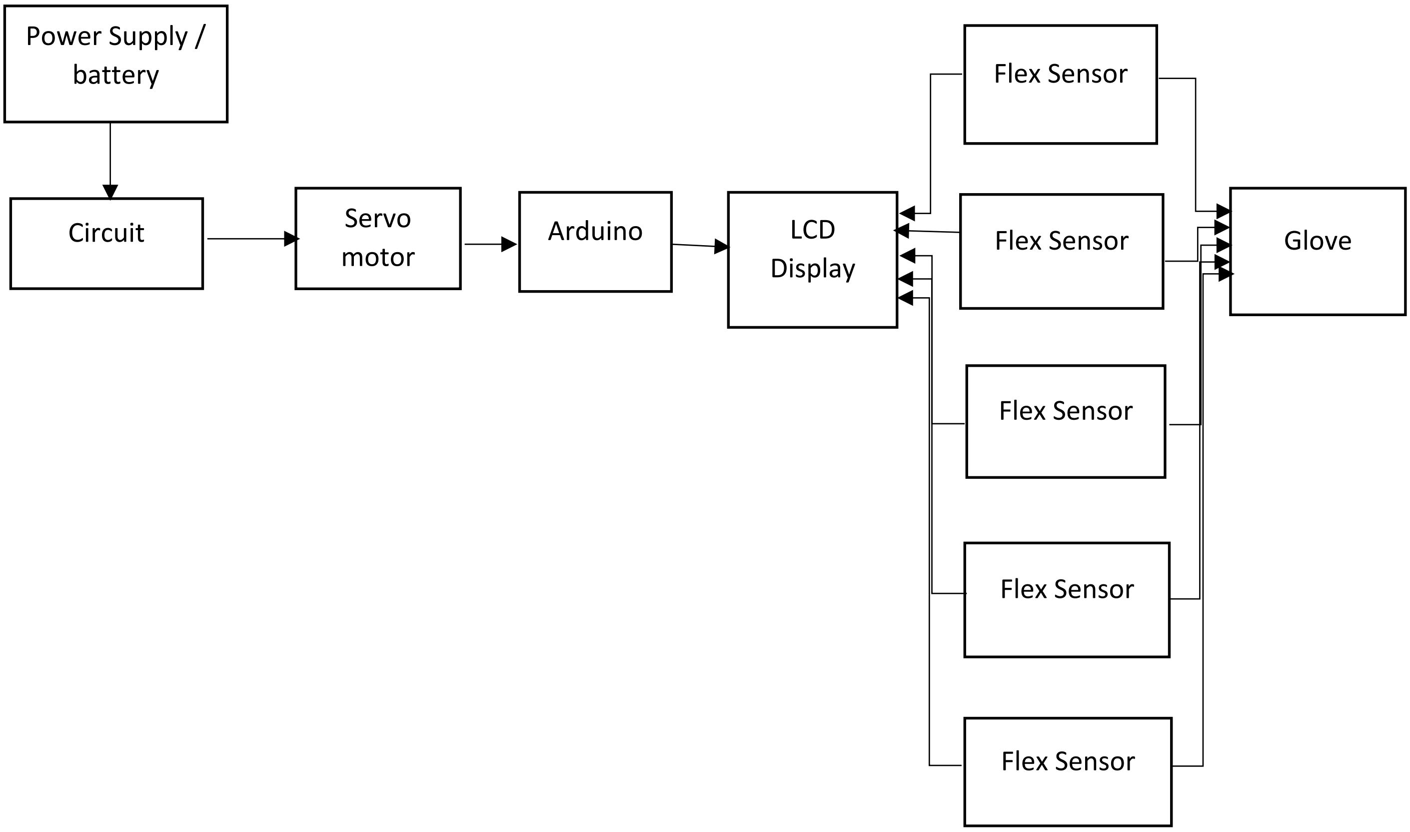
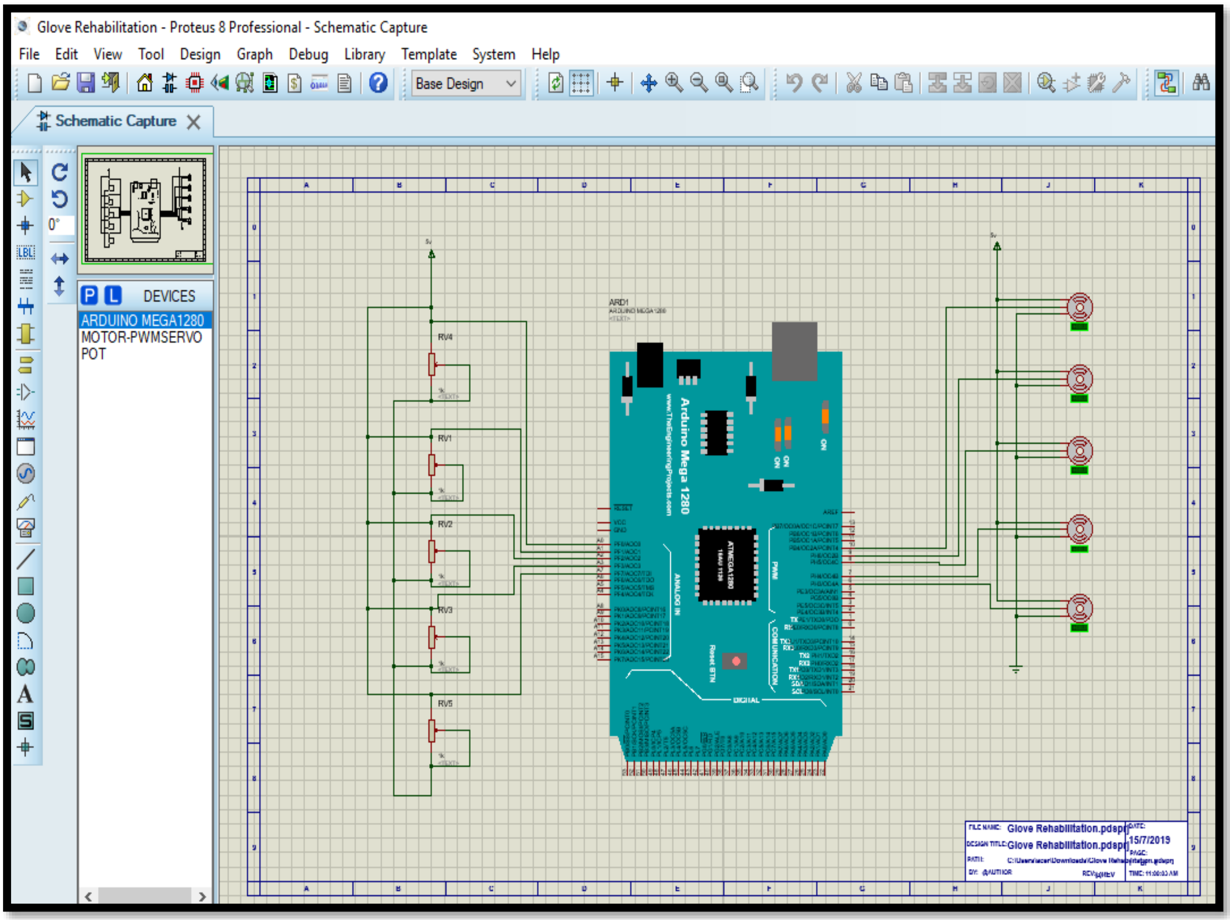
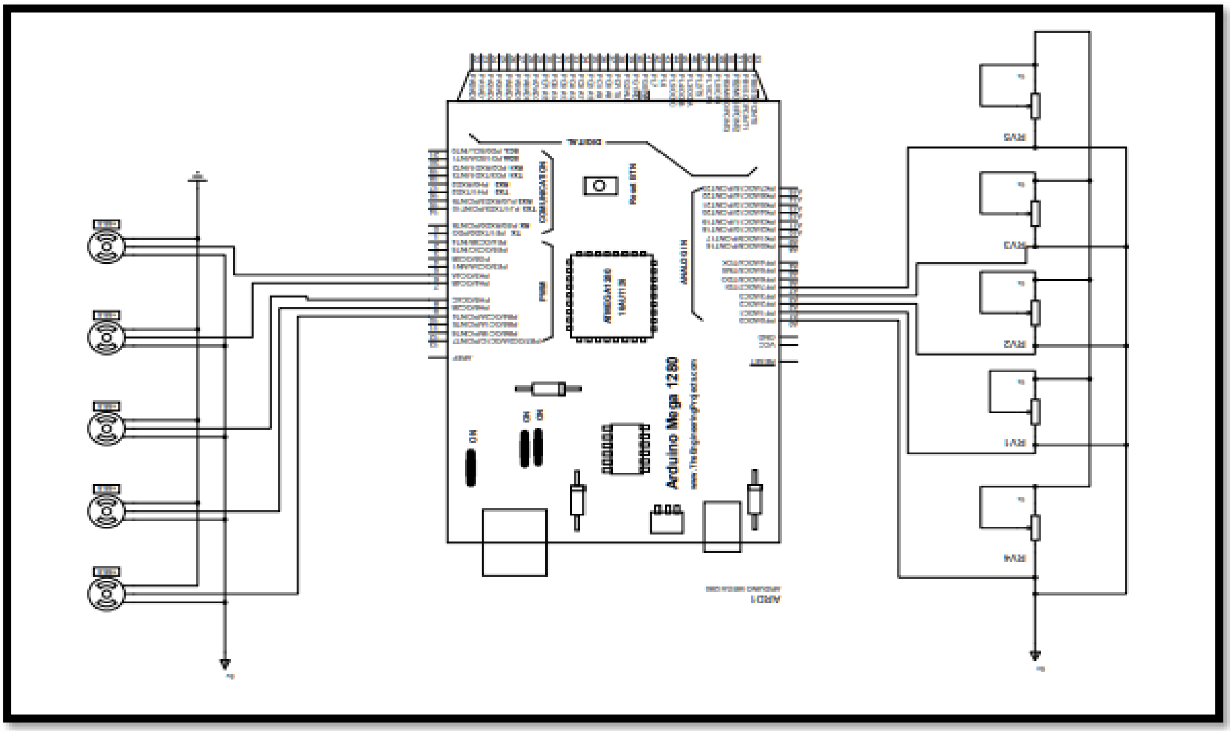


Figure 3.4: Block Diagram of the Project

The recovery of the glove finger (GFR) has the function to help stroke patients to flexion and extend the hands (grasp and release). Thus, the project block diagram described is shown as Figure 3.3.2. First, there is a power supply to support the voltage to the circuit such as adapter or battery. Second, the circuit's decision has been made based on the GFR function. The circuit is selected based on observations on all aspects that benefit GFR. The circuit has been connected to five servo motors. Thirdly, all five motor servos are fitted with nylon strings. Then, each nylon strings attached to the servo motors must be connected to all five fingers of the glove.

3.4 Circuit of Project





3.5 Coding Arduino of Project

```
#include <SPI.h>        // Include SPI library (needed for the SD card)
#include <SD.h>         // Include SD library
#include <SoftwareSerial.h>
#include <LiquidCrystal_I2C.h>

const int chipSelect = 4;

int flex1Pin = A0; //pin A0 to read analog input
int flex2Pin = A1;
int flex3Pin = A2;
int flex4Pin = A3;
int flex5Pin = A6;
int sensor1;
int sensor2;
int sensor3;
int sensor4;
int sensor5;


int Jari1=0 ;//save analog value
int Jari2=0 ;
int Jari3=0;
int Jari4=0;
int Jari5=0;
int average;

LiquidCrystal_I2C lcd(0x27,16,2);


void setup() {
```

```
Serial.begin(9600);



lcd.init(); //initialize the lcd
lcd.begin(16,2);   // iInit the LCD for 16 chars 2 lines
lcd.backlight();   // Turn on the backligt (try lcd.noBaklight() to turn it off)
lcd.setCursor(0,0); //First line
lcd.print("FINGER GRIPPER");
lcd.setCursor(0,1); //Second line
lcd.print("  DATA LOGGER ");
delay(1000);
lcd.clear();
lcd.setCursor(0,0); //First line
lcd.print("READY TO TEST ");
delay(2000);
lcd.clear();

while (!Serial) {
  ; // wait for serial port to connect. Needed for native USB port only
}

Serial.println("........................NEW Page card.....................");
Serial.print("Initializing SD card...");

// see if the card is present and can be initialized:
if (!SD.begin(chipSelect)) {
  Serial.println("Card failed, or not present");
  // don't do anything more:
  while (1);
}*/
Serial.println("card initialized.");
```

```
}



void loop() {
 delay(5000); //  variable time record persecond
  sensor1 = analogRead(flex1Pin);         //Read and save analog value from potentiometer
 Jari1 = (sensor1-1023)*100/(951-1023);    // percentage formula
 Serial.println("value1=");
 Serial.println(sensor1);
  Serial.print(Jari1);
  Serial.print("% , ");
  delay(500);
  lcd.setCursor(0,0); //First line
  lcd.print("1=");
  lcd.print(Jari1);
  lcd.print("  ");


  sensor2 = analogRead(flex2Pin);         //Read and save analog value from potentiometer
  Jari2 = (sensor2-826)*100/(973-826);
  Serial.println("value2=");
  Serial.println(sensor2);
 Serial.print(Jari2);
  Serial.print("% , ");
  delay(500);
  lcd.setCursor(6,0); //First line
  lcd.print("2=");
  lcd.print(Jari2);
  lcd.print("  ");
```

```
sensor3 = analogRead(flex3Pin);        //Read and save analog value from potentiometer
Jari3 = (sensor3-824)*100/(973-824);
Serial.println("value1=");
Serial.println(sensor3);
Serial.print(Jari3);
Serial.print("% , ");
lcd.setCursor(12,0); //First line
lcd.print("3=");
lcd.print(Jari3);
lcd.print("  ");

sensor4 = analogRead(flex4Pin);        //Read and save analog value from potentiometer
Jari4 = (sensor4-779)*100/(973-779);
Serial.println("value1=");
Serial.println(sensor4);
Serial.print(Jari4);
Serial.print("% , ");
lcd.setCursor(0,1); //First line
lcd.print("4=");
lcd.print(Jari4);
lcd.print("  ");

sensor5 = analogRead(flex5Pin);        //Read and save analog value from potentiometer
Jari5 = (sensor5-826)*100/(970-826);
Serial.println("value1=");
Serial.println(sensor5);
Serial.print(Jari5);
Serial.print("% , ");
lcd.setCursor(6,1); //First line
lcd.print("5=");
```

```
 lcd.print(Jari5);
 lcd.print("  ");
 Serial.println("");

 average=(Jari1+Jari2+Jari3+Jari4+Jari5)/5*100/100;
Serial.println(average);
 lcd.setCursor(11,1); //First line
 lcd.print("A=");
 lcd.print(average);
 lcd.print("%");
 lcd.print("  ");

File  dataFile = SD.open("DataLog.txt", FILE_WRITE);

 dataFile.println ("*****************DataLog In Pecentage*****************");
 // if the file opened okay, write to it:
 if (dataFile) {



   dataFile.print("JARI  ( 1 , 2 , 3 , 4 , 5 ) = ");
   dataFile.print("(");
   dataFile.print(Jari1);
   dataFile.print(" , ");
   dataFile.print(Jari2);
   dataFile.print(" , ");
   dataFile.print(Jari3);
   dataFile.print(" , ");
   dataFile.print(Jari4);
   dataFile.print(" , ");
   dataFile.print(Jari5);
```

```
    dataFile.print(")");
    dataFile.print("");


    dataFile.println("");
    dataFile.println("");
    dataFile.print("          ********* TOTAL AVERAGE *********");
    dataFile.println("");
    dataFile.print("                     ");
    dataFile.print(average);
    dataFile.print("%");
    dataFile.println("");
    dataFile.println("");
    dataFile.println("");


    dataFile.close();


  }
  // if the file didn't open, print an error:
  else
    Serial.println("error opening PercentageAllLog.txt");*/
}
```

3.6 Main Components:

There is the main components that used for doing the project. All components are selected based on observations on all aspects that benefit the project.

1)Arduino Mega

Arduino mega are The MEGA 2560 that is designed for more complex projects. With 54 digital I/O pins, 16 analogue inputs and a larger space for your sketch it is the recommended board for 3D printers and robotics projects. This gives your projects plenty of room and opportunities [45]. The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analogue inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno [45].

Table 2.1 Technical specs

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
LED_BUILTIN	13
Length	101.52 mm
Width	53.3 mm
Weight	37 g

The Mega 2560 can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector [45] .The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may become unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

Vin. The input voltage to the board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin [45]. 5V. this pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it [45]. 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA. GND. Ground pins [45]. IOREF. This pin on the board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs for working with the 5V or 3.3V. The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM [45]. Each of the 54 digital pins on the Mega can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50 k ohm. A maximum of 40mA is the value that must not be exceeded to avoid permanent damage to the microcontroller. In addition, some pins have specialized functions. Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX). Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega16U2 USB-to-TTL Serial chip. External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2). These pins can be configured to trigger an interrupt on a low level, a rising or falling edge, or a change in level. See the attachInterrupt() function for details. PWM: 2 to 13 and 44 to 46. Provide 8-bit PWM output with the analogWrite() function.SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS). These pins support SPI communication using the SPI library. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Arduino /Genuino Uno and the old Duemilanove and Diecimila Arduino boards. LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off. TWI: 20 (SDA) and 21 (SCL). Support TWI communication using the Wire library. Note that these pins are not in the same location as the TWI pins on the old Duemilanove or Diecimila Arduino boards [46].

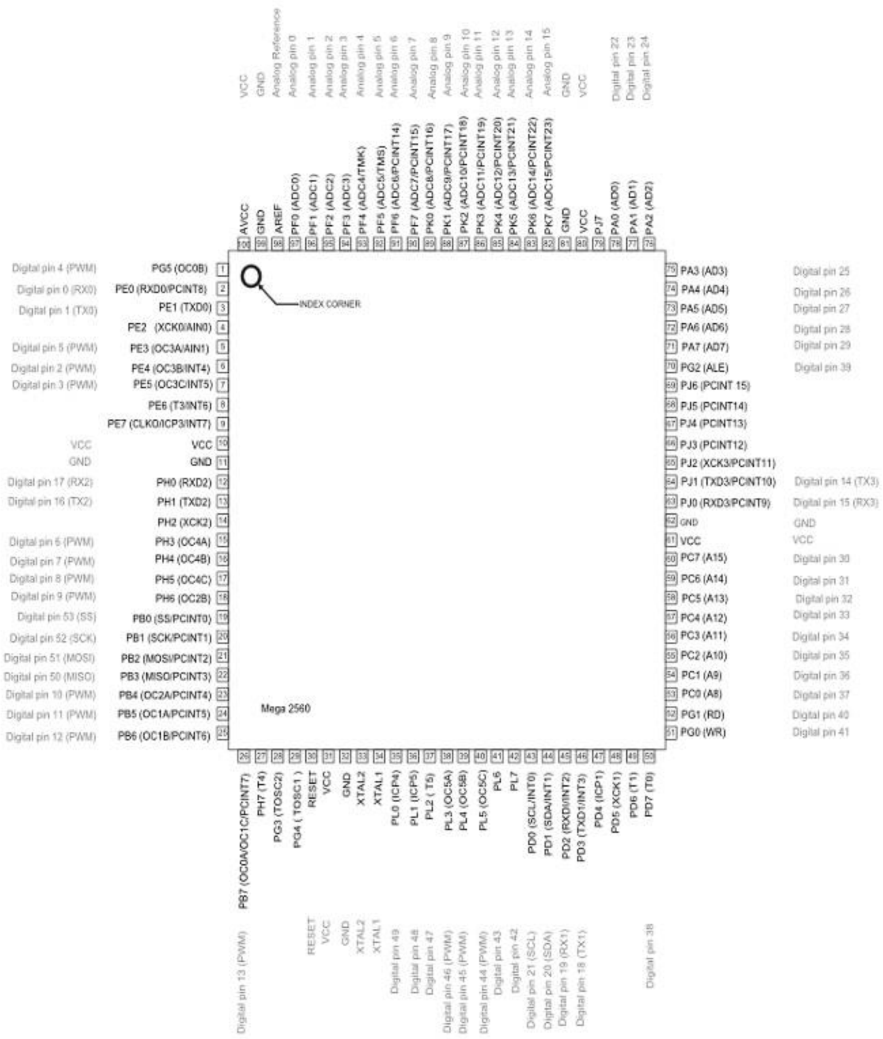


Figure 2.13 Arduino Mega 2560 PIN mapping table

Table 2.2 pin number, pin name and, apped pin name

Pin Number	Pin Name	Mapped Pin Name
1	PG5 (OC0B)	Digital pin 4 (PWM)
2	PE0 (RXD0/PCINT8)	Digital pin 0 (RX0)
3	PE1 (TXD0)	Digital pin 1 (TX0)
4	PE2 (XCK0/AIN0)	
5	PE3 (OC3A/AIN1)	Digital pin 5 (PWM)
6	PE4 (OC3B/INT4)	Digital pin 2 (PWM)
7	PE5 (OC3C/INT5)	Digital pin 3 (PWM)
8	PE6 (T3/INT6)	
9	PE7 (CLKO/ICP3/INT7)	
10	VCC	VCC
11	GND	GND
12	PH0 (RXD2)	Digital pin 17 (RX2)
13	PH1 (TXD2)	Digital pin 16 (TX2)
14	PH2 (XCK2)	
15	PH3 (OC4A)	Digital pin 6 (PWM)
16	PH4 (OC4B)	Digital pin 7 (PWM)
17	PH5 (OC4C)	Digital pin 8 (PWM)
18	PH6 (OC2B)	Digital pin 9 (PWM)
19	PB0 (SS/PCINT0)	Digital pin 53 (SS)
20	PB1 (SCK/PCINT1)	Digital pin 52 (SCK)
21	PB2 (MOSI/PCINT2)	Digital pin 51 (MOSI)
22	PB3 (MISO/PCINT3)	Digital pin 50 (MISO)
23	PB4 (OC2A/PCINT4)	Digital pin 10 (PWM)
24	PB5 (OC1A/PCINT5)	Digital pin 11 (PWM)
25	PB6 (OC1B/PCINT6)	Digital pin 12 (PWM)
26	PB7 (OC0A/OC1C/PCINT7)	Digital pin 13 (PWM)

27	PH7 (T4)	
28	PG3 (TOSC2)	
29	PG4 (TOSC1)	
30	RESET	RESET
31	VCC	VCC
32	GND	GND
33	XTAL2	XTAL2
34	XTAL1	XTAL1
35	PL0 (ICP4)	Digital pin 49
36	PL1 (ICP5)	Digital pin 48
37	PL2 (T5)	Digital pin 47
38	PL3 (OC5A)	Digital pin 46 (PWM)
39	PL4 (OC5B)	Digital pin 45 (PWM)
40	PL5 (OC5C)	Digital pin 44 (PWM)
41	PL6	Digital pin 43
42	PL7	Digital pin 42
43	PD0 (SCL/INT0)	Digital pin 21 (SCL)
44	PD1 (SDA/INT1)	Digital pin 20 (SDA)
45	PD2 (RXDI/INT2)	Digital pin 19 (RX1)
46	PD3 (TXD1/INT3)	Digital pin 18 (TX1)
47	PD4 (ICP1)	
48	PD5 (XCK1)	
49	PD6 (T1)	
50	PD7 (T0)	Digital pin 38
51	PG0 (WR)	Digital pin 41
52	PG1 (RD)	Digital pin 40
53	PC0 (A8)	Digital pin 37
54	PC1 (A9)	Digital pin 36
55	PC2 (A10)	Digital pin 35
56	PC3 (A11)	Digital pin 34
57	PC4 (A12)	Digital pin 33

58	PC5 (A13)	Digital pin 32
59	PC6 (A14)	Digital pin 31
60	PC7 (A15)	Digital pin 30
61	VCC	VCC
62	GND	GND
63	PJ0 (RXD3/PCINT9)	Digital pin 15 (RX3)
64	PJ1 (TXD3/PCINT10)	Digital pin 14 (TX3)
65	PJ2 (XCK3/PCINT11)	
66	PJ3 (PCINT12)	
67	PJ4 (PCINT13)	
68	PJ5 (PCINT14)	
69	PJ6 (PCINT 15)	
70	PG2 (ALE)	Digital pin 39
71	PA7 (AD7)	Digital pin 29
72	PA6 (AD6)	Digital pin 28
73	PA5 (AD5)	Digital pin 27
74	PA4 (AD4)	Digital pin 26
75	PA3 (AD3)	Digital pin 25
76	PA2 (AD2)	Digital pin 24
77	PA1 (AD1)	Digital pin 23
78	PA0 (AD0)	Digital pin 22
79	PJ7	
80	VCC	VCC
81	GND	GND
82	PK7 (ADC15/PCINT23)	Analog pin 15
83	PK6 (ADC14/PCINT22)	Analog pin 14
84	PK5 (ADC13/PCINT21)	Analog pin 13
85	PK4 (ADC12/PCINT20)	Analog pin 12
86	PK3 (ADC11/PCINT19)	Analog pin 11
87	PK2 (ADC10/PCINT18)	Analog pin 10
88	PK1 (ADC9/PCINT17)	Analog pin 9
89	PK0 (ADC8/PCINT16)	Analog pin 8

90	PF7 (ADC7)	Analog pin 7
91	PF6 (ADC6)	Analog pin 6
92	PF5 (ADC5/TMS)	Analog pin 5
93	PF4 (ADC4/TMK)	Analog pin 4
94	PF3 (ADC3)	Analog pin 3
95	PF2 (ADC2)	Analog pin 2
96	PF1 (ADC1)	Analog pin 1
97	PF0 (ADC0)	Analog pin 0
98	AREF	Analog Reference
99	GND	GND
100	AVCC	VCC

The Mega 2560 has 16 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and analogReference() function. There are a couple of other pins on the board. AREF. Reference voltage for the analog inputs. Used with analogReference(). Second, reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board [45]. The Mega 2560 board has a number of facilities for communicating with a computer, another board, or other microcontrollers. The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication. An ATmega16U2 (ATmega 8U2 on the revision 1 and revision 2 boards) on the board channels one of these over USB and provides a virtual com port to software on the computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the board as a COM port automatically. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the ATmega8U2/ATmega16U2 chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A SoftwareSerial library allows for serial communication on any of the Mega

2560's digital pins. The Mega 2560 also supports TWI and SPI communication. The Arduino Software (IDE) includes a Wire library to simplify use of the TWI bus; see the documentation for details. For SPI communication, use the SPI library. Physical Characteristics and Shield Compatibility. The maximum length and width of the Mega 2560 PCB are 4 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Three screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins [45].

The Mega 2560 is designed to be compatible with most shields designed for the Uno and the older Diecimila or Duemilanove Arduino boards. Digital pins 0 to 13 (and the adjacent AREF and GND pins), analog inputs 0 to 5, the power header, and ICSP header are all in equivalent locations. Furthermore, the main UART (serial port) is located on the same pins (0 and 1), as are external interrupts 0 and 1 (pins 2 and 3 respectively). SPI is available through the ICSP header on both the Mega 2560 and Duemilanove / Diecimila boards. Please note that I2C is not located on the same pins on the Mega 2560 board (20 and 21) as the Duemilanove / Diecimila boards (analog inputs 4 and 5). Automatic (Software) Reset in Mega 2560 is rather then requiring a physical press of the reset button before an upload, the Mega 2560 is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the ATmega2560 via a 100 Nano farad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino Software (IDE) uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the boot loader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload [45]. This setup has other implications. When the Mega 2560 board is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via

USB). For the following half-second or so, the bootloader is running on the ATMega2560. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data. The Mega 2560 board contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details [45].

2) Servomotor

Figure 3.9 Tower Pro MG995 Metal Gear Servo

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servo motors, or servos are self-contained electric devices that rotate or push parts of a machine with great precision. Servos are found in many places: from toys to home electronics to cars and airplanes. If you have a radio-controlled model car, airplane, or helicopter, you are using at least a few servos. In a model car or aircraft, servos move levers back and forth to control steering or adjust wing surfaces. By rotating a shaft connected to the engine throttle, a servo regulates the speed of a fuel-powered car or aircraft. Servos also appear behind the scenes in devices we use every day. Electronic devices such as DVD and Blu-ray Disc players use servos to extend or retract the disc trays.

For the project, the string is attached to the servomotor to create a movement of flexion and extension of hand. This servo can be purchased with 180 or 360 degree rotation for robotics applications. The type of servomotor we use is 'Tower Pro MG995 Metal Gear Servo', as shown in the **Figure 3.9**.

Table 3.1: The Specifications for Tower Pro Mg995 Metal Gear Servo:

Modulation:	Digital
Torque:	**4.8V:** 130.54 oz-in (9.40 kg-cm) **6.0V:** 152.76 oz-in (11.00 kg-cm)
Speed:	**4.8V:** 0.20 sec/60° **6.0V:** 0.16 sec/60°
Weight:	1.94 oz (55.0 g)
Dimensions:	**Length:**1.60 in (40.7 mm) **Width:**0.78 in (19.7 mm) **Height:**1.69 in (42.9 mm)
Motor Type:	Tower Pro MG995 Metal Gear Servo
Gear Type:	Metal
Rotation angle:	180 Degree
Pulse Cycle:	1 ms
Connector Type:	JR

3) Gloves

Figure 3.10

The project have used cotton glove because this glove more lightly and it will make the servo motor can more easily in pull and push sessions.

4) Ni-Cd Battery 4.8V 700mah

Figure 3.11

Glove Finger Rehabilitation used Ni-Cd battery as a supply. Battery can survive with 5 RC servo motor for 2 hours. The size of this battery is 50mm x 55mm x 14mm. Normal capacity for this battery is 700mah and the normal voltage is 4.8V. The cell of each battery is 1.2V and the number of cell is 4. It suitable for Ni-Cd Battery Charger 4.8V. To charging the battery, it take 4 until 5 hours to full charges. For the full charged voltage is 6.4V.

5) Ni-Cd Battery Charger 4.8V

Figure 3.12

The type battery Suitable is 4.8V Ni-Cd. The Input is 110-240V ~ 50/60Hz and the Output is Regulated + 4.8VDC 250mA. If No load voltage is 7.11V. After that, the Charging time for fully battery is 4-5 hour.

6) **SERIAL 12C LCD (16X2)**

It can display 16 characters per line and there are 2 such lines

3.7 Sample of Questionnaire

Before Use GFR

We are a student of the Polytechnic Engineering Department of Sultan Salahuddin Abdul Aziz Shah from the Department of Electronic Engineering (Medicine) who wishes to conduct questionnaires and analysis on our Final Project. You are asked to answer some of the questions we provide below. Our project is associated with physiotherapy on the arms and fingers after the patient has been attacked by 'Stroke'.

Please mark [/] based on the space provided.

Gender:

Men [ ]

Women [ ]

Age:

Under 20 [ ]

20-30 [ ]

31-40 [ ]

41-50 [ ]

51-60 [ ]

Work Sector:

Student [ ]

Employee [ ]

Please tick (/) based on the statements provided in the scale below.

1	2	3	4	5
Disagree	Not Satisfied	Satisfly	Agree	Strongly Agree

No.	Statement	1	2	3	4	5
1	Stroke are very dangerous					
2	Stroke attack the victim from various ages.					
3	The probality of stroke that been face by the aged people are high.					
4	Stroke sufferer could be treated.					
5	Stroke patient takes a long time to recover.					
6	The frequency of physiotherapy process are the higher factors for recovery process					
7	The ability of hand (finger) are the most affected part of the patient Stroke.					
8	Stroke patient need an extra supervision.					
9	This Physiotherapy device are portable to bring anywhere.					
10	Physiotherapy device could help increasing the recovery process.					

After use GFR

QUESTION AIR

We are the student for Department of Electrical Engineering of Polytechnic

Sultan Salahuddin Abdul Aziz Shah from the Department of Electronic Engineering (Medical) wanting to do questionnaires and analysis on our Final

Project. You are asked to answer some of the questions we have provided below. Our project is associated with physiotherapy on the fingers after the patient that is been attack by a 'Stroke'.

Order

Please mark [⁄] based on space that has been provide.

Gender:

Man [ ]

Woman [ ]

Age:

20-30 [ ]

31-40 [ ]

41-50 [ ]

51-60 [ ]

Others (State) [ ]

Work Sector:

Student [ ]

Worker [ ]

Please mark (⁄) based on the statement that has been provide by the scale below.

1	2	3	4	5
Disagree	Not Satisfactory	Satisfactory	Agree	Very Agree

Bil	Statement	1	2	3	4	5
1	The device could help the stroke patient in their rehabilitation process.					
2	This device bring an impact in increasing the frequent for the patient to perform this therapy in their recovery process.					
3	This device could help perform grasp and release of finger.					
4	This device could help the stroke patient to perform therapy without frequent supervision by the physiotherapy staff.					
5	This device are comfortable to be wearing.					
6	The device could measure how much percent of the finger of patient that can be bent.					
7	The device could help therapist to identify the patient's health status.					
8	The project easy to identify and measure results are displayed on the mobile phone					
9	This project can control servo motor using smart phone application					
10	This project suitable for patient that have stroke level one and two					

3.8 Gantt chart

Project 1

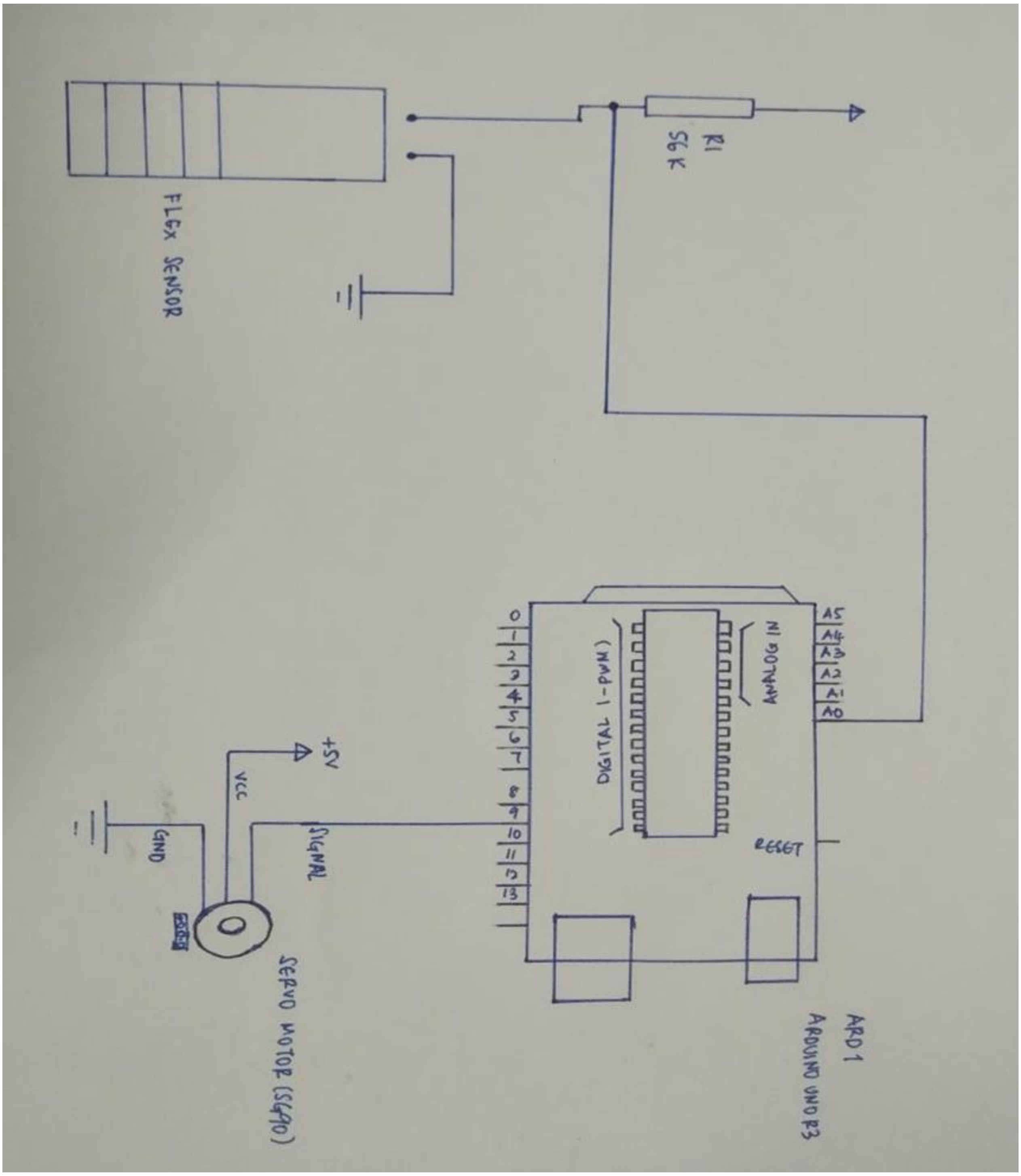
LECTURE WEEKS / PROJECT ACTIVITIES	LW1	LW2	LW3	LW4	LW5	LW6	LW7	LW8	LW9	LW10	LW11	LW12	LW13	LW14	LW15
INTRODUCE TO PROJECT	■														
SELECTING ON PROJECT OPTIONAL		■													
PRESENT AND DEFENDING PROJECT TITLE			■												
MAKING A PROPOSAL				■											
SEARCHING THE LITERATURE					■	■	■	■							
MAKE A RESEARCH ABOUT LR						■	■	■							
COMPLETE THE LITERATURE						■	■	■							
PREPARING THE METHODOLOGY									■						
RESEARCH AND DESIGN THE CIRCUIT										■					
PRODUCE A SCHEMATIC PROJECT											■	■	■		
FINALIZE THE CIRCUIT											■	■	■		
PRESENTATION OF PROJECT														■	
SUBMISSION OF FINAL REPORT PROPOSAL															■

Project 2

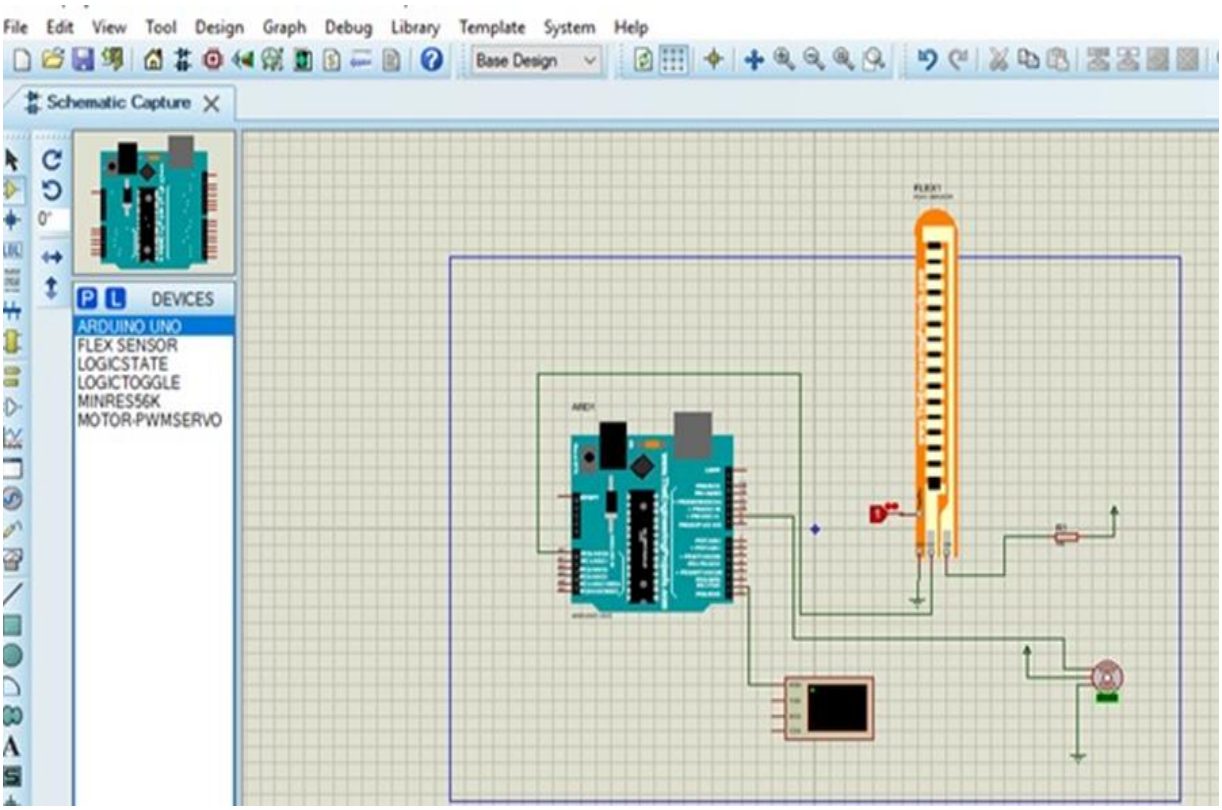
BIL	WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	DATE	4/7	11/7	18/7	25/7	1/8	8/8	22/8	29/8	5/9	12/9	19/9	26/9	3/10	10/10
1.	DISCUSSION ABOUT PROGRESS PROJECT	■	■	■	■										
2.	PRESENTATION OF PROGRESS PROJECT					■									
3.	PROGRESS OF TECHNICAL PAPER AND REPORT						■	■							
4.	TESTING AND EVALUATION								■	■					
5.	SUBMIT OF FINAL REPORT										■				
6.	SURVEY ABOUT COMPETITION											■			
7.	PRESENTATION OF PROJECT												■		
8.	PROJECT DEMONSTRATION													■	■

3.9 Mini Project

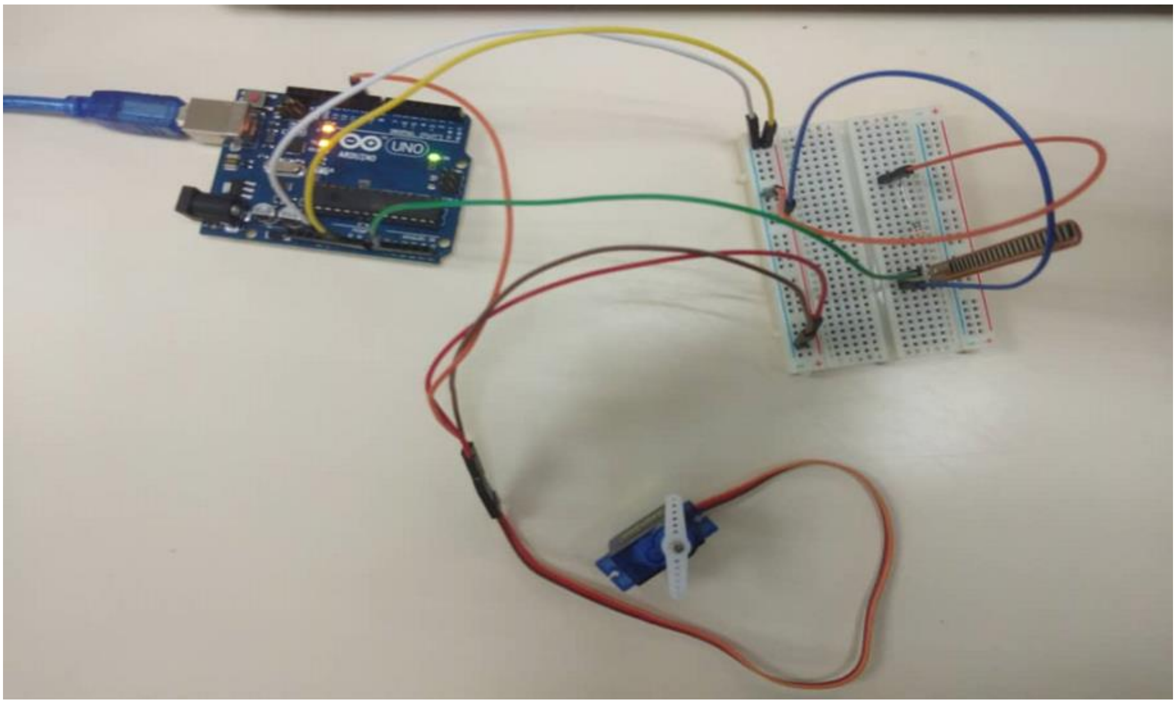
Schematic Diagram



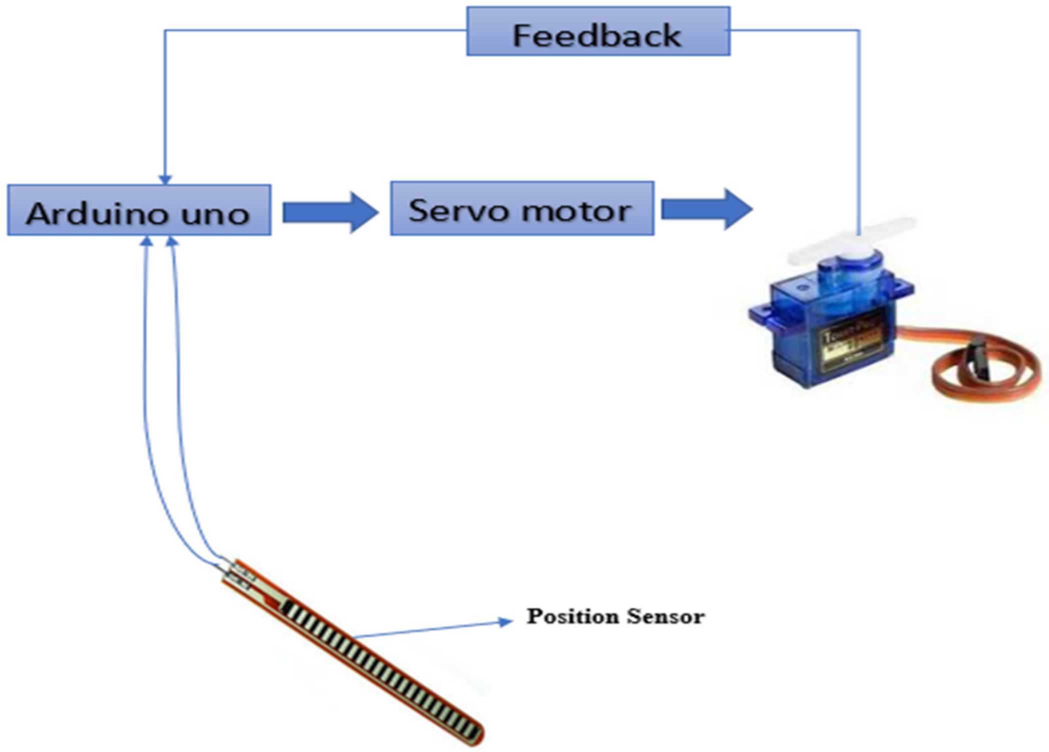
Circuit Operation



t



Block Diagram

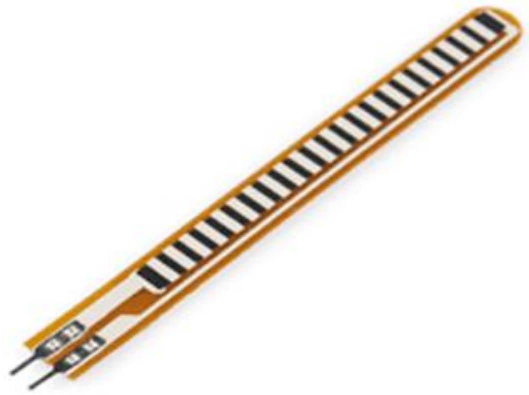


Name Of Component

1. **Arduino Uno R3**

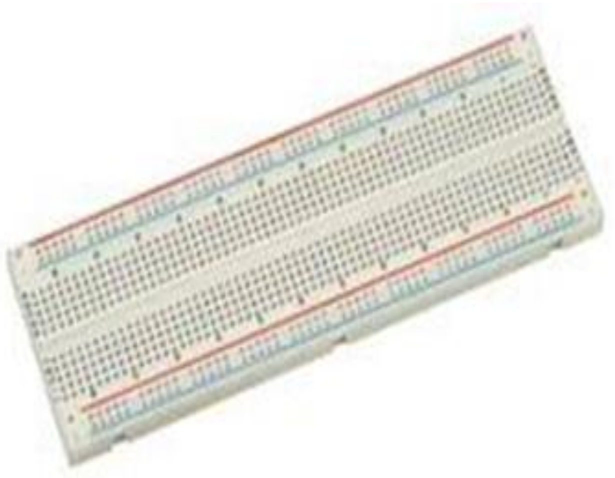
2. **Servo motor**

3. **Flex sensor**



4. **Jumper wires**

5.	**Breadboard**



6.	**56K ohms resistor**

RESULT/ANALYSIS AND DISCUSSION

4.1 Introduction

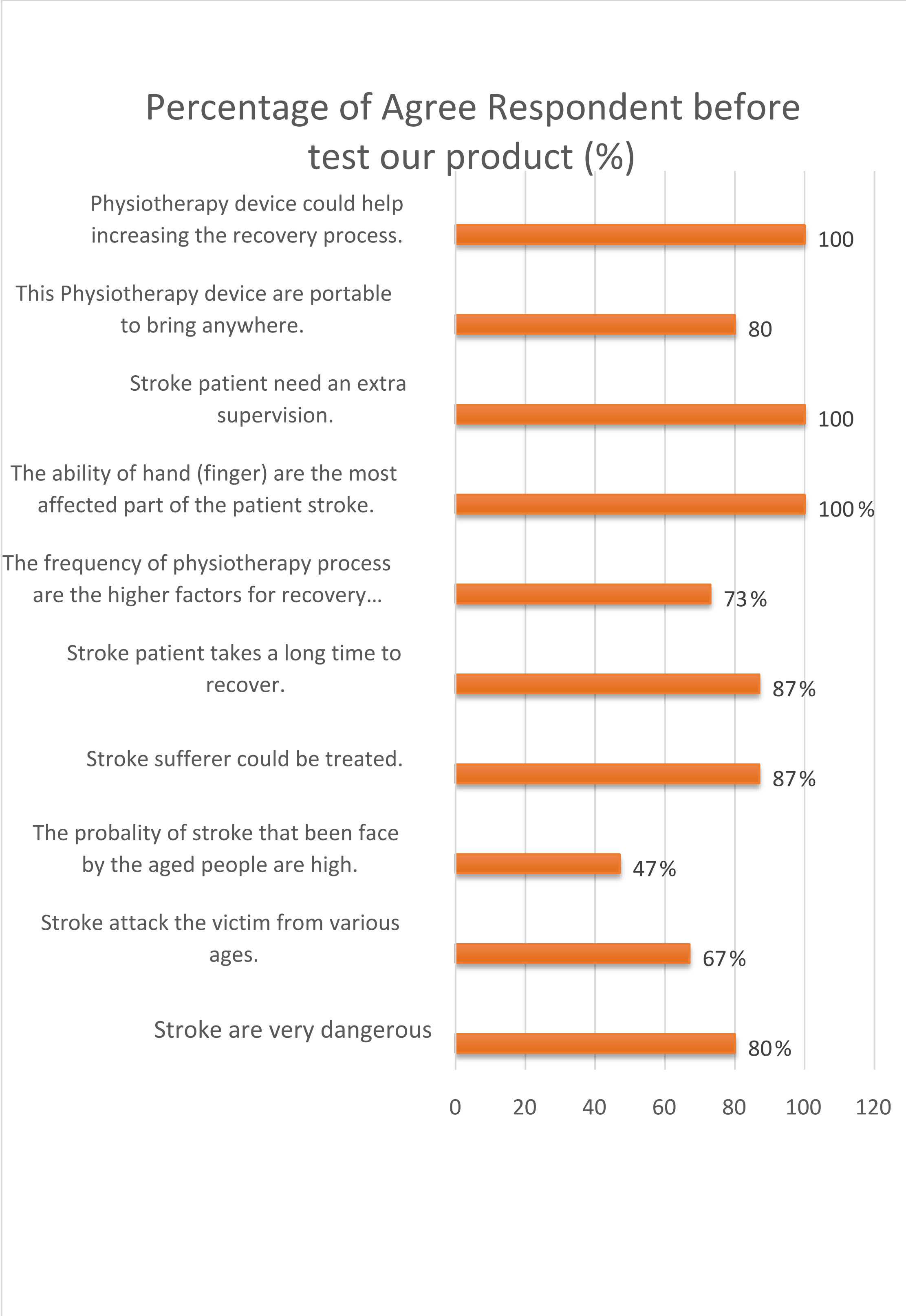
By the end of this project, this therapy glove has been successfully created and we believe that it can help and ease the stroke rehabilitation process. This project can help people with stroke diseases to recover their senses by doing this simple rehabilitation. It is also to help minimize the movement of patient on their own during treatment and to help stroke victims or patients with lack of finger movement regain mobility in their hand. This therapy glove can perform the extension and flexion movement, the same movement that was made by the hand.

4.2 Result

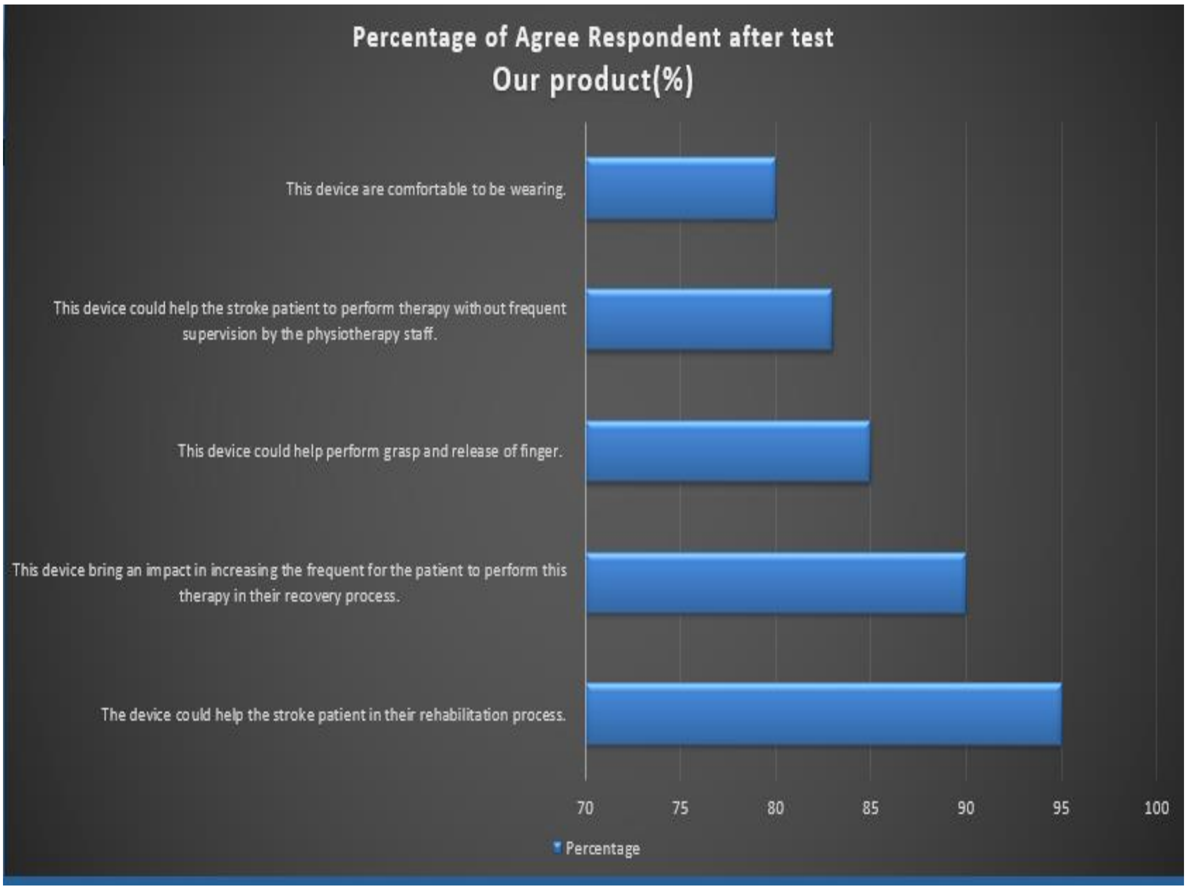
After doing some survey, a few questions were create regarding the idea of Glove Finger Rehabilitation (GFR). The questions consist of people's opinion and acceptance about the idea. The feedback regarding the idea is analysed.

Do qualitative and quantitative chart based on responders' answers. Below is the sample of the questionnaire that is divided to two sections. First section is demography part and the laryngoscope application satisfaction.

Figure 4.1: Analysis Question Air before Test GFR



In the pre questionnaire, we are doing survey on the need of rehabilitation equipment and about the stroke patient itself. We have prepared10 questions on this part and the result is shown in **Figure 4.1.** As the result, there were 3 questions that reach the highest result (100%), firstly, the rehabilitation equipment can improve the recovery process, stroke patients need to be monitored more often and hand's ability is frequently be part of body that affected by stroke. Then, there were there questions that reach between 80% and 87% where the respondents agreed stroke takes a long time to recover, stroke can be treated, and stroke is very dangerous disease. Finally, the lowest percentage which is 47% on the probability the old citizen to have stroke is high.



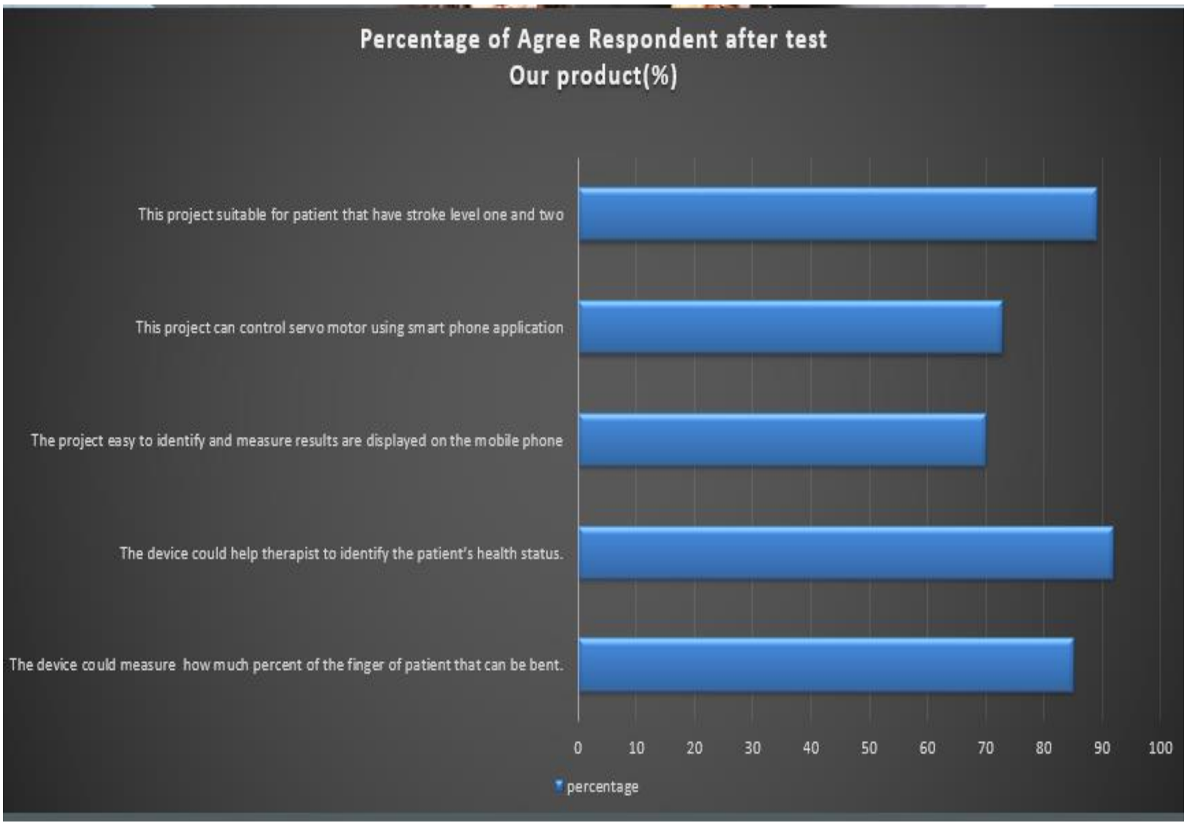


Figure 4.2: Analysis Questionnaire after Using GFR

Based on analysis on the post questionnaire that has been made as shown in Figure 4.2, that many respondents agreed that the glove finger rehabilitation can be a helper in rehabilitation process, which reach the highest percentage which is, 95% compared to others. The lowest percentage hits at 70% on the device could can help therapist to identify the patient's health status.Next, 95% respondents agreed that the device could help the stroke patient in their rehabilitation process.

CONCLUSION

Based on the objective we can conclude that by develop this device it could help the patient to having a daily treatment without frequent assistance from the therapist.Those who benefit most Physical Therapy are individuals who are in need of restoring injured body parts ,increasing flexibility, or building strength. We also help improve posture, which if left uncorrected can cause damaging musculoskeletal conditions. Additionally, we help patients who have undergone surgeries and who are in need of therapy to regain optimal physical functionality. Physical Therapists help restore function, improve mobility, relieve pain, and prevent or limit permanent physical disabilities of patients suffering from injuries or disease. They restore, maintain, and promote overall fitness and health.

Next,this product would help the patient to perform grasp and release concept of their finger mobility in a self-help manner. A recovery focused atmosphere that allows for learning, personal growth, coping and self-care strategies for the patient. Opportunities to learn effective techniques in areas of personal development, which enable one to recover their identity and being to experience life beyond a mental health/addiction issue.

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